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A BEHAVIORISTIC EXPERIMENT ON INDUCTIVE INFERENCE[1]

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I. INTRODUCTION

1. *Statement of the Problem.*—The purpose of the present investigation was to bring to light the different modes of language response involved in the processes of inductive inference, *i.e.*, to study by means of what was ostensibly a memory experiment, the spontaneous discovery of the common structure of compound Chinese characters and the relationship which this common structure represented.

2. *Meaning of the Term.*—In the present study I have borrowed the term 'Inductive Inference' from the logician, but I shall use it with a purely objective connotation; that is, I shall use it to designate merely the type of language responses involved in the solution of certain problems. In other words, by inductive inference I mean merely a series of language reactions to different stimulus settings or different groups of stimulus patterns *when these latter have each an element in common*, and provided that this language series terminates in a new organization or regrouping of words ('conclusion,' or statement of law, or principle), and provided

[1] The experiment was performed in the Psychological Laboratory of the University of California during the academic year, 1921–1922. Professor E. C. Tolman has given invaluable counsel and assistance in the course of the experiment and in the reading of the manuscript. Professor G. M. Stratton has helped very much by taking friendly interest in the work and by making valuable suggestions. I take pleasure in acknowledging deepest indebtedness to them. Thanks are also due to Drs. John B. Watson and Warner Brown, who have kindly read the manuscript and given judicious criticisms and suggestions.

that this new organization, in turn, is such as might become an abridged, economical, and general adjustment act of the organism in response to any stimulus setting in which the constant stimulus-factor may be present. To illustrate, suppose we ask a speaking animal to solve a Yerkes multiple choice problem. We tell him to work with his mouth instead of with his hands. From trial to trial we vary the number of keys (different stimulus patterns) but always keep the right key in the center (constant stimulus-factor). Our animal will at first display a number of random guesses, and he solves the problem only by accident. But if our animal is not of the 'feebleminded' type he will, after a number of trials, discover the rule of the game: he will tell the experimenter that the right key is always in the center. On later trials he verifies his conclusion. Since the discovery of this rule, his verbal responses are simplified and economized; thereafter, in any given trial, instead of guessing randomly from one key to another as he did at the beginning, he will immediately say: "The middle key is the correct one." Now we call this whole process of language responses 'inductive inference,' stressing the fact that it terminates in the discovery of the rule of the game, or the solution of the problem. This is, of course, a very simple case illustrating the process of inductive inference. But the principle is the same, essentially, whether our animal is discovering the law of gravitation or is finding out the solution of a problem even simpler than that of the multiple choice experiment.

It is thus well to note at the outset that in the experiment which is to be reported below, we are merely dealing with a type of language reaction (which, due to lack of better terminology, we have called inductive inference). We are not studying 'higher mental process,' 'reasoning,' or 'thinking' or anything of that kind, as these terms are commonly used by the present-day traditional psychologists. As we shall see later, throughout the whole experiment we did not ask our subject any question concerning what might be going on in his so-called 'consciousness'; nor did we attempt any inference with reference to the latter. *In other words, in our*

experiment we accepted the overt language reactions of the subject at their face value and treated them in precisely the same way in which we would ordinarily treat the movements of a rat in a maze.

3. *Historical.*—There have been practically no objective studies in human behavior which have any direct bearing upon my present problem. There are over a dozen articles and monographs reporting *introspective* studies of 'abstraction' or 'generalization.' But I need not give any account of them here because while they are attempting an 'introspective' examination of 'conscious content' during the process of 'abstraction' I am confining myself to an objective study of overt verbal responses. C. L. Hull's objective experiment upon 'quantitative aspects of the Evolution of Concepts'[1] is more closely related than any of the studies in 'abstraction' mentioned above to my problem. The mere fact that Hull and I have used Chinese characters as materials for our researches will at once suggest a close relation between us. The problems which we work on are, however, different. While Hull is interested mainly in determining the relative efficiency of different methods for the evolution of 'concepts,' my own interest lies, as we have already seen, in studying the various modes of language reaction involved in the process for which I have used the term inductive inference. Consequently, the methods we have employed are also different, although we both stress the factor of 'spontaneity' by our procedures. J. C. Peterson has reported an experiment entitled 'The Higher Mental Process in Learning.'[2] While the method he has used is, in certain respects, objective his results have little direct bearing upon my study. In the field of comparative psychology my study is very intimately connected with the Yerkes multiple choice method and with Hamilton's study of the perseverance method of learning in monkeys, human defectives, and children.

II. Description of the Material

1. *The General Nature of Chinese Compound Characters.*—The materials used in this experiment were eighty-eight *compound* Chinese characters. To understand them

[1] Psychological Monog. 28, No. 1, 1920.

[2] Psychological Monog. 28, No. 7, 1920.

thoroughly it is necessary first to describe briefly the general nature of the Chinese character. In the Chinese language one can usually (but not always) separate a 'compound' character into two components. Each 'component' often has a meaning by itself and can be an independent character when it is written alone. For example, in Plate I, column three, the first compound character, meaning 'to bark,' consists of two parts, one on the left meaning 'mouth' and one on the right meaning 'dog.' Now while 'mouth' and 'dog' are here combined to form a compound character—'to bark'—they are often used in Chinese as two independent words. Very often one of the two components of a compound character is written on the left side and the other part on the right. But there are many cases where one component is written at the top and the other part at the bottom. There are also compound characters which are made up of *more than two components*. But this has nothing to do with the purpose of our experiment. The reader may consider every compound character in Plate I as having only two components, which are all written side by side with the exception of the three characters, 'friend,' 'oxygen,' and 'to dance.'

In a great many cases the meaning of a compound character is derived from the meanings of its two components. Thus, 'to bark' is very closely related in meaning to 'mouth' and to 'dog,' which are its two components. But more frequently the meaning of a compound character is derived from only one of its two components, while no significant connection can be traced in the other part. For example, in the first column, Plate I, the first compound character, 'to bathe,' is composed of two parts, one meaning 'water,' the other 'tree.' While there is a close connection between 'to bathe' and 'water,' it is obvious that the meaning of the compound character has nothing to do with 'tree.' All the compound characters which served as material in this experiment were selected from this latter class; that is to say, the meanings of these compound characters are derived from, or related to, the meanings of one (and one only) of their two components.

It is to be noted that the statement made above concerning the nature of the compound characters cannot be universally applied in the Chinese language. There are many compound characters whose meanings have nothing to do with any of their components. Furthermore, a compound character may have several meanings, and it is not necessary that each of its meanings be related to its components. In the present experiment, however, the compound characters have been so selected and so translated that their meanings always have a connection with their *left-side* components. The translation, in many cases, is very arbitrary, and is justified only by the fact that it is rendered merely to suit the purpose of the experiment. The terminology used for this description is also arbitrary, and for the most part is not of Chinese origin. In this connection the writer wishes to ask indulgence for changing some of the original forms of the compound Chinese characters, and for coining several new characters which never appear in a Chinese dictionary.

2. *The Preliminary Experiment.*—The compound characters used in this investigation, their 'radicals,' 'pseudo radicals,' the 'misleading characters,' the 'negative instance characters,' and the 'component card board,' which will be described presently, as well as the technique of the experiment, were selected and determined on the basis of the results of a preliminary experiment in which some twenty persons served as subjects. For the sake of brevity this preliminary experiment will not be described here. We mention it simply to emphasize the empirical character of the materials chosen for the final experiment.

3. *The Radicals and Other Components.*—Of the eighty-eight compound Chinese characters used in the present study, seventy-five belong to five common *radicals*.

PLATE I

氵	Water	女	Female	口	Mouth	扌	Hand	金	Metal	Non Radical Characters	
沐	To Bathe	姊	Elder Sister	吠	To Bark	持	To Carry	鑌[7]	Penny	碘	Iodine
灌	Share	媽[1]	Mother-in-Law	叱	To Hoot	指	Pointing	鎷[1]	German Mark	硫	Sulphur
游	To Swim	妗[6]	Aunt	吟[6]	Singing	推	To Push	銑	Shilling	瑪[1]	Agate
洪	Flood	媳	Daughter-in-Law	吐	To Vomit	挽	To Pull	鋼[5]	France	碌	Green Jasper
浪[3]	Billow	嫂	Sister-in-Law	嚕	Talkative	扯	To Tear	鎳	Nickle	養[3]	Oxygen
濱[7]	Coast	嬤	Mama	喃	To Chatter	撥	Picking	鉀	Potassium	行[9]	Walking
潮	Current	妹	Younger Sister	呼	To Cry	握	To Hold	鈉	Sodium	舞	To Dance
沸[5]	Boiling	娘[3]	Mother	囈	Talking in-Sleep	摺	Folding	鐳	Radium	叔[10]	Uncle
流[6]	To Drift	姪	Niece	唢	Whistling	投	To Throw	鋅	Zinc	友[10]	Friend
江	River	妯	Brother's Wife	吻	To Kiss	搖	Shaking	鎂	Magnesium	師	Teacher
沃	Irrigation	姨	Wife's Sister	咬[2]	To Bite	掛	To Hang	鋃[3]	Lock	徙[9]	Jumping
深	Deep	姆	Tutoress	唾	Saliva	掃	Sweeping	鈴[6]	Bell	駮[2]	Fierce Beast
灣	Bay	媚	Flirtation	喝	Drinking	打	To Strike	鐲	Bracelet	彿[5]	Buddha
沈	Sinking	婷	Graceful	吮	To Suck	托	To Lift	鉸[2]	Shears		
源	Spring	姣[2]	Beauty	吹	To Blow	掘	To Dig	鍊	Chain		

They are, thus, divided into five groups, each having fifteen characters. The characters of each group have a radical in common. The radicals always appear in the left hand side of the compound characters (see Plate I.). *Each of these five radicals has a definite meaning which can be inferred from the common element in the meanings of the compound characters in which the radical appears. As has been stated previously, the main purpose of the experiment was to investigate the modes of responses to the inferential situations; viz., to study those language reactions involved in the discovery of the common structure of the compound characters—namely, the radical—and of the common meaning or common relationship which this radical represents.*

The five radicals signify (1) *water*, (2) *female*, (3) *mouth*, (4) *hand*, and (5) *metal*. (For the sake of easy identification by the reader these radicals are isolated in the first horizontal row in Plate I. In the actual experiment, however, they never appeared in isolation except in the component card board which will be described very shortly.) The reader can readily see by examining Plate I. that all the fifteen compound characters having the *water* radical on the left are connected with water. An analogous situation holds for each of the other four groups of characters. (All the compound characters having a radical in common are shown in a vertical column. There are five columns of these characters. In the plate each character is parallelled by its English equivalent.)

4. *The Negative Instance Characters and the Misleading Characters.*—In examining Plate I., one will notice that many of the compound characters having a common radical may tend to lead the subject to form a wrong hypothesis regarding the meaning of that radical. Of the fifteen compound characters having the female radical, eleven refer to female relation or relative, such as 'sister,' 'mother-in-law,' 'aunt,' 'daughter-in-law,' etc. Of those having the mouth radical, three have more or less connection with talking or speaking ('talkative,' 'to chatter,' and 'talking in sleep,' and probably 'to cry'), and nine appear to have something to do with 'voice,' or 'sound,' or 'noise' ('to bark,' 'to hoot,' 'singing,' 'whistling,' 'to vomit,' 'talkative,' 'to chatter,' 'talking in sleep,' 'to cry,' and probably 'to kiss'). All of those having the hand radical are very likely to lead the subject to the conclusion that the radical means action, or movement, or motion. Finally, of those having the metal radical, five ('nickel,' 'penny,' 'German mark,' 'shilling,' and 'franc') would suggest the common meaning money, or coin, while six ('magnesium,' 'radium,' 'zinc,' 'potassium,' 'sodium,' and 'nickel') would suggest chemical element. We shall call these compound characters which may tend to lead the subject to such wrong conclsions, '*misleading characters.*' (In the water radical there are no such characters.) In order to prevent the subject from being actually misled to such conclusions, or, after he has been so misled, in order to make him realize the inadequacy of such conclusions, there must be negative cases which would make the conclusions untenable. This requirement was fulfilled by the *negative instance characters*. There are two types of negative instance characters, namely, *those within the radical group and those outside the radical group*. The negative instance characters within the radical group are compound characters which have the same radical as the misleading characters, while those outside the radical group have no structure in common with the latter.

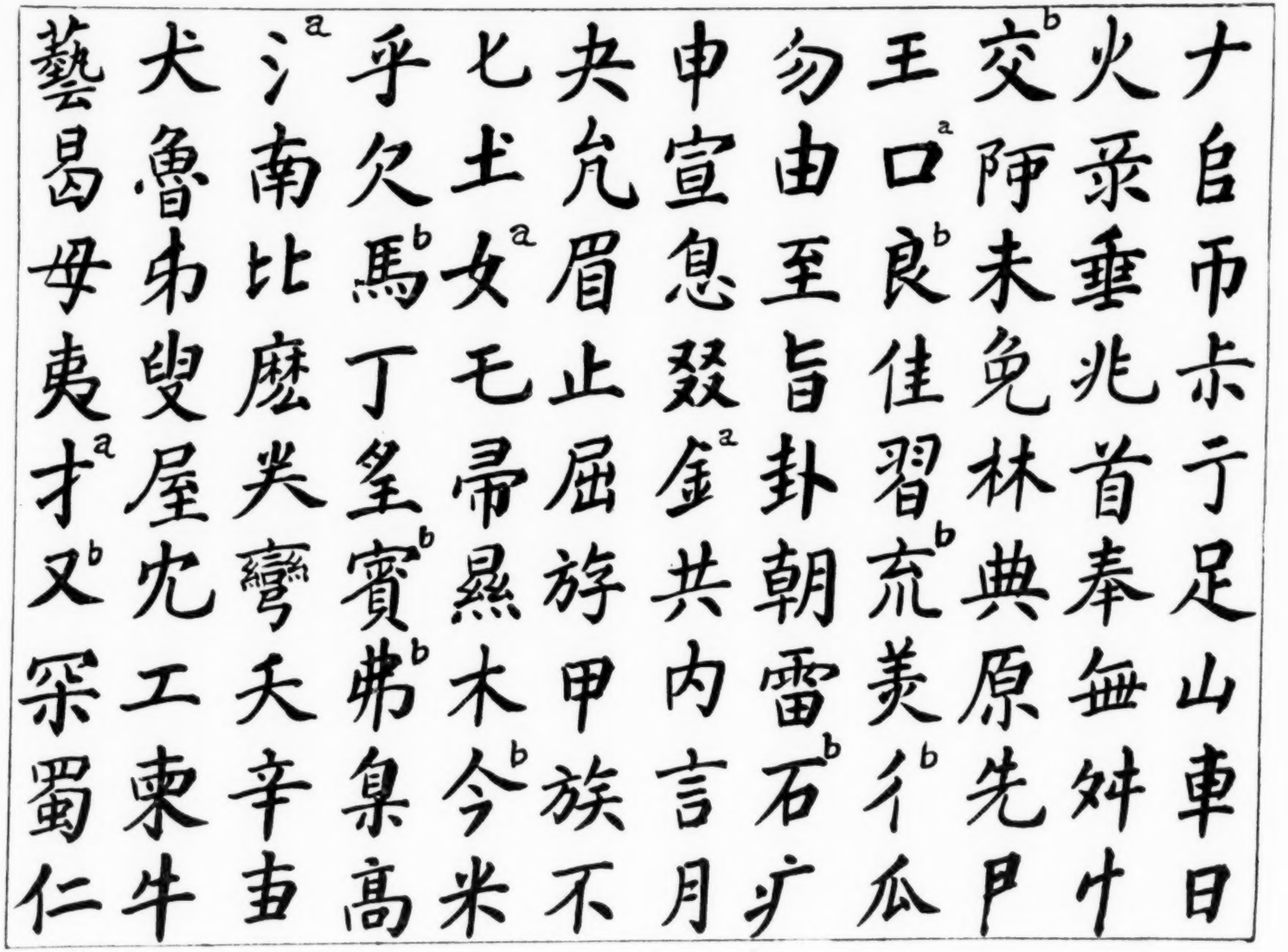
In Plate I., in the second vertical column, under the female radical, the last four compound characters ('tutoress,' 'flirtation,' 'graceful,' and 'beauty') are negative instance characters which oppose the meaning of relation, or relative. In the third column, under the mouth radical, the last six compound characters ('saliva,' 'to kiss,' 'to bite,' 'drinking,' 'to suck,' and 'to blow') will contradict the hypothesis of either voice, or talking, or speech. In the fifth column, under the metal radical, the last ten

compound characters have nothing to do with money or coin, while the first four and the last five are not necessarily connected with chemical elements, so that they will contradict either of these theories. The results of our preliminary experiment had shown that each of the five radicals was often regarded by the subjects as a part of speech, such as noun, or verb, or infinitive. The negative instance characters against such conclusions are numerous both within and without the radical group.

It was also found in the preliminary experiment that the subject often suggested a meaning for a radical which was too broad or too comprehensive. In such cases there were no negative instance characters within the group containing the radical which could contradict the conclusion. In the fourth column, under the hand radical, there does not seem to be any character which will necessarily oppose the conclusion that all the compound characters in this radical group are related to action, or movement, or motion. (They are not actions in general, but *motions with the hand*. Therefore, the conclusions that the radical means hand, or action (or motion) with the hand, will, in fact, be accepted as correct, but the word action, or motion, alone, will be considered incorrect). The female radical may be taken to mean 'human being,' or 'person,' or 'personal,' instead of female; the metal radical may be regarded as 'chemical,' 'or 'mineral,' instead of metal. (In the last case the subject would insist that those 'money' characters—'franc,' etc.—and such characters as 'bell,' 'shears,' etc., are really made of chemical elements or of mineral material, so that they do not seem to oppose the idea that the radical means chemical or mineral.) To make it clear that all such theories are incorrect it was necessary, therefore, to provide another group of negative instance characters outside the radical group. These are provided in the last vertical column of Plate I. Against the meaning of human being, or personal, we have characters—'uncle,' 'friend,' and 'teacher'—which do not have the female radical (note that the character 'uncle' will also contradict the relative, or relation, hypothesis). Against the meaning of action, or motion, the characters 'walking,' 'jumping,' and 'to dance' also refer to action or movement, but do not have the hand radical. And against the meaning of chemical or mineral, the characters 'agate,' 'green jasper,' 'oxygen,' 'sulphur,' and 'iodine' do not have the metal radical.

5. *The Pseudo Radicals.*—In Plate I. there are ten components each of which appears in two or more compound characters. From the standpoint of conventionalized usage in language the compound characters which have these components have, however, no common relationship in meaning, as can be shown by examining their English equivalents, shown in the plate. Hence the subject cannot legitimately infer any meaning for these components. We shall call these components *pseudo radicals*. They are marked off in Plate I. by the Arabic figures. (These pseudo radicals are meaningful, however, to one who is familiar with the Chinese language.) The purpose in providing these pseudo radicals was to test the ability of the subject to eliminate them as non-essential elements, on the ground that no general connection could be found between the compound characters in which they appeared.

6. *The Component Card Board.*—On this card board (Plate II.) the components of the eighty-eight compound characters were written separately. The radicals, as well as the pseudo radicals, were also written on it in isolation. In addition, there are twenty-four new characters which do not appear among the words shown in Plate I. Practically all the words on the card board have meanings by themselves in the Chinese language. But the subject has no source from which to learn them except in the cases of the five radicals. The radicals and pseudo radicals are scattered around on the card board. For the sake of easy examination by the reader, the radicals are designated



by the letter 'a' and the pseudo radicals by the letter 'b.' The purpose and use of this card board will be explained in the next section, in connection with technique.

The card board was a white thick card board, twelve inches high and fifteen inches long. The characters on it were all black.

7. *The Colors of the Characters.*—In the actual experiment each compound character was written in two colors (black and green) so as to enable the subject to separate it into its two parts more easily. No uniform color was used, however, either for the radical component or for the other part; in fact, regularity of color in either of the two components of a given compound character was carefully avoided: sometimes the radical component appeared in black, with the other parts in green, and sometimes the colors were reversed.

8. *The Arrangement of the Compound Characters in the Experiment.*—The eighty-eight compound characters shown in Plate I. were presented to the subject in eight series, each series being written on a strip of white thick paper, which, in turn, was glued to white oilcloth. Each series contained eleven characters, one of which was a non-radical character while all the other ten belonged to the five radical groups. Thus each of the five radicals appeared in two of the characters of each strip. The size of the character was approximately one square inch. Any two compound characters which had the same radical were always written five or six words apart from each other, so as not to let the subject observe two compound characters of the same radical in immediate succession. Each character was written on the left side of the strip, while its English equivalent went alongside it on the right. There was another set of eight strips containing the same characters and with the same arrangement as the first set, but without their English equivalents. This duplicate set was used for testing the recall of the English meanings for the Chinese characters.

III. Description of the Technique

1. *Subjects.*—Sixty university students, twenty-seven men and thirty-three women, served as subjects in this experiment. Most of these subjects had not had any course in psychology, and only a few were at the time taking a course in elementary psychology. It can be safely stated that practically all of these subjects had not been baptized by the psychologist, and were relatively innocent of the sacred art of self-observation. The writer believes that for any objective experiment, subjects of this type are by far better than the introspectively trained psychologists who are good only for being 'observers' but who can seldom act as animals to be 'observed.' None of our subjects were acquainted with the Chinese language.

2. *The Experiment Understood by the Subject as a Memory Test.*—As the main purpose of this experiment was to study the process of inductive inference in an objective way, it was necessary that the subject should not know our real aim but should discover the meanings of the radicals *spontaneously*

and incidentally. He was, therefore, told that the experiment was solely a memory test. All suggestions as to the common radicals and their relation to the meanings of the individual compound characters were carefully avoided. He was given a mass of unorganized and seemingly disconnected Chinese characters, with their English equivalents, and left to himself to organize them and to make any inferences with regard to the radicals he might be capable of. The instructions, which were in written form, were as follows:

Instruction I.: "You will be shown a number of Chinese characters, with their English equivalents, on the drum of the apparatus in front of you. You are to memorize the English meaning for each of these characters. You will have three and a half seconds to examine one character. After you have examined all the characters on the drum I shall show you the same characters without their English translations and ask you to recall the English word for each of them. You are to learn eighty-eight characters, which are divided into eight series. The test will be considered as complete when you are able to recall the English meanings for all these characters."

Practically all of our subjects expressed surprise when they were told at the conclusion of the experiment that they had been tested for something other than 'memory.' Even the very brightest subjects, who had got all the correct meanings for the five radicals before they committed all the characters to memory, confessed that they had not suspected the real purpose of the experiment.

3. *The Apparatus, Exposure-Time, etc.*—The experiment was carried out by means of Hull's memory apparatus.[1] For detailed description of the apparatus see Hull's monograph, which I have previously referred to. The time exposure was three and a half seconds. Two trials (repetitions) were given each day for every strip of characters. In each trial the characters were shown twice, the first with English, the last without, so as to test the number of characters that had been memorized. It usually took from four to eight experiment days to complete the experiment for one subject. Each experiment day lasted from forty to fifty minutes.

Before the experiment was started the subject was asked to agree to two conditions: (1) he should not try to recall or have anything to do with the characters outside the labora-

[1] The writer is indebted to Dr. Hull for his kindness in letting him use the apparatus and for a valuable description of the operation of its mechanism.

tory; (2) he should not talk to any person, especially those who had served as subjects or who had volunteered to do so in the near future, about the nature of the experiment. The experimenter explained to him that the observance of these two conditions was very necessary in order to eliminate the effects of uncontrolled conditions upon the efficiency of memory.

4. *Testing the Recognition of the Radicals and Pseudo Radicals.*—To test the recognition of the radicals and pseudo radicals the following methods were adopted:

After every trial, the subject was given the 'component card board' to examine, with the following instruction:

Instruction II.: "The characters on this card board are components of Chinese characters. Some of them you have not seen before, but a great many of them have appeared as components in the words which you are learning to remember. Please pick out those components which have appeared *in more than one of the words* you are learning. This is to test whether or not you can recognize the components as well as you do the whole words."

Here again no word was mentioned about the fact that there was such a thing as a radical. All the subjects took it as a part of the memory test, and were very anxious to pick out as many correct components as possible so as to make a good score. They usually picked out other components besides radicals and pseudo radicals, while some or many of the latter were often overlooked by them.

5. *Testing Inference.*—Many subjects who had discovered the meanings of some radicals were so excited that they could not help speaking to the experimenter about their discovery before they were given the component card board to examine. Others would make some special comments on the radicals regarding their meanings as they were picking them from the card board. In such cases the experimenter simply recorded what they said, and no further testing was needed. If, however, the subject failed to make such comments himself either before or during the examination of the component card board, the following method was adopted to find out whether or not he had discovered any meanings for the radicals. The experimenter showed him on a sheet of paper all the components which he had just picked out from the card board, and asked the following 'detective question:'

Question 1.: "What makes you think that these components rather than others have appeared in more than one of the words which you are learning, or how could you distinguish these from other components which do not appear in more than one character? Do you have any comments to make on some of these components?"

This question was asked in a very unsuspicious and indifferent manner, the experimenter explaining to the subject that he simply wanted to find out what method he used to memorize the characters and to recognize their components. Responding to this question the subjects would make comments of all sorts upon the components they had picked out; *e.g.*, "This (pointing to a certain component) has a peculiar look which attracts my attention," or "This has appeared in many words but I don't remember what they are," or "This looks so different from others that I can always recognize it," or "I recognize it by its looks," or "I simply happen to recognize it but I don't know how I do it," etc. But those subjects who had discovered any meaning at all for a radical, or had made some inference with regard to a pseudo radical, never failed to respond to the above question in a strikingly different way. For example, in commenting on the 'female' radical they would immediately say, "This is a symbol (or is a sign, or signifies, or has connection with, etc.) for female (or relative, or person, as the case might be) because all the words in which this component appears have something to do with female. This is what helps me to remember its frequent appearance in the words shown on the drum."

The subjects were asked to make comments not only upon the radicals and pseudo radicals, but also upon other components, so as to avoid arousing their suspicion that the experimenter was especially interested in certain particular components.

6. *Testing the Detection of Negative Instances.*—After the subject had made such comments, he was asked to recall the words in which the components he had picked out appeared. Here again the experimenter explained to him that this was also a part of the memory experiment. In a word, the task of the subject in the whole experiment, as he himself understood it to be, was: (1) to memorize the English meanings for the Chinese characters shown on the drum; (2) to

recognize and to pick out the components of frequent appearance from the component card board; and (3) to recall the characters which had these components in common. The subjects who did not discover any meaning were also asked to recall.

So far as the radicals and pseudo radicals were concerned, this recall was designed to serve two purposes: (1) the number of compound characters recalled by the subject for a given radical can be counted upon as the number of evidences upon which the subject based his inference with regard to the meaning of that radical; and (2) the compound characters he recalled indicated whether or not the subject took into consideration the negative instance characters when he made the inference. If (*a*) the conclusion drawn by the subject regarding the meaning of the radical was such as to be negated or contradicted by the negative instance characters, we can safely assume that either such negative instance characters were forgotten by him at the time when the conclusion was drawn, or, though remembered, they did not appear to him as negative cases. If the former was the case, the negative instance characters would not be included in the words recalled by the subject; if the latter was the case, he should be able to recall the negative instance cases without, however, recognizing the contradiction. On the other hand, (*b*) if the subject reached a right conclusion concerning the meaning of a given radical, there were two possibilities: first, he might or might not have been able to make use of the negative instance characters within the radical group as positive evidences to support his conclusions (note that such negative instance characters became negative cases against a conclusion *only* when such a conclusion was based solely upon the common characteristic of the misleading characters); or, second, he might or might not take into account also the negative instance characters outside the radical group, at the time the conclusion was drawn. The former could easily be determined by finding out whether or not the negative instance characters within the radical group were included in the compound characters recalled by the subject. The latter was determined by the following method:

To illustrate, let us recall that all the compound characters in the 'hand' radical seem to have some connection with action or movement, and that there does not seem to be any character having the same radical which would militate against the inference that the radical means action or movement. All the negative instance characters in this case were outside the radical group. Now if our subject concluded that the radical signified hand, instead of action or movement, we wished to know whether he arrived at such a conclusion merely by chance or as a result of careful consideration of the negative instance characters outside the radical group. A good detective question method would settle this problem:

Question II.: After the subject had recalled the compound characters for, say, the hand radical, the experimenter showed these characters to him, pointing out that they all had more or less connection with action or movement, and asked whether he thought that for the meaning of the component (radical) 'action,' or 'movement,' was better than the 'hand' which he had suggested. (The wording of the question was identically the same for every subject and was given in a very indifferent manner so as not to arouse any suspicion in the subject.)

Now, if our subject had considered the negative instance characters outside the radical group before he drew the conclusion, he immediately replied that the component in question could not mean action or movement, because the characters 'walking,' 'jumping,' and 'to dance' had also connection with action or movement, but that they did not have this same symbol (radical). If the question failed to induce him *immediately* to give such an answer, we felt safe in concluding that he reached the right conclusion regarding the meaning of the hand radical merely by accident. (The reaction time between this detective question and the answer of the subject was taken with a stop watch.)

(Ordinarily the subject who drew a right conclusion merely by chance, when facing the above detective question, did one of the following things: (1) he answered that he was not sure which of the proposed meanings (hand, or action, or movement) was the better; or, (2) that both meanings seemed to be correct; or, (3) that hand seemed to be more exact (narrower) than action or movement, but that he was unable to give any reason for it—that is, he did not mention the fact that 'walking,' 'jumping,' and 'to dance' contradicted the latter meaning; or, (4) he merely agreed that action or movement was better than hand; or, (5) he might do either (1), (2), (3), or (4) at first, but after a moment's consideration (in this case his reaction time was usually long) he finally recalled these negative instance characters and therefore concluded that

hand was the best meaning after all; or, (6) he might at first do either (1), (2), or (3), or (4), but upon a later trial of the memory experiment, notice the negative instances, and thereupon decide that hand was better than action or movement. This furnished us further evidence that he did not consider these negative instances when he first inferred the meaning of the radical. It also indicated that this detective question had served as a suggestion-stimulus leading him to notice the negative instances which he had passed over, otherwise.)

Those who failed to notice the negative instance characters, and hence drew a wrong conclusion, were given ample opportunity to detect them when they came back again to learn the compound characters shown on the drum. Here as elsewhere the factor of spontaneity was greatly stressed; the subject was left to himself to detect the negative instances without any aid or hint from the experimenter. If he happened to discover them, the experimenter recorded it, and also the number of trials between this discovery and the first formulation of the incorrect hypothesis. The reaction or attitude of the subject toward the negative instance characters, after they had been discovered, was also noted.

7. *Variation of Method.*—When the subject had learned all eighty-eight characters, the experiment was discontinued in case he had got all the correct meanings for the five radicals. Otherwise the following variations of method were used:

(*a*) If the subject, though he had mastered the eighty-eight characters, failed to get all or some of the meanings for the radicals, but was able to pick the radicals from the card board, he was given the following written instruction at the end of the 'memory' experiment:

Instruction III.: "These are the components you have just picked out from the card board. Now some of these components have meanings by themselves (that is, they can be independent words when they are not written in combination with other components) but many of them do not. Today you are to find out which of these have meanings by themselves and which do not. You can surely distinguish the meaningful components from the meaningless ones if you think carefully. If you think a component has a meaning, you must tell me what it means and give your reason for the conclusion. Give me as many concrete reasons or grounds as you can, upon which your conclusion is based; do not omit any, for your credit will be partly based upon the number of reasons or grounds you can give. Tell me all the guesses as to the meaning of a component which you have in your mind, whether you think they are correct or not, for a guess which may seem to you wrong may sometimes be just the right one. You will have five minutes for one component. You are allowed to withdraw or modify your conclusion whenever you want to, but you must tell me the reason for doing so. Read the instruction over again if you are not sure of what you are asked to do."

(*b*) If the above instruction failed to make the subject get all the correct meanings for the five radicals, he was then retested for the retention of the English equivalents for the eighty-eight compound characters. The instruction for the retest was as follows:

Instruction IV.: "I am going to test you again and see how many characters you still can remember. Please note that some of your conclusions concerning the meanings of the components are not satisfactory, and though some of them are correct you have not given as many grounds to support them as you could. While you are viewing the characters in the drum you may discover some new meaningful components, or find it necessary to change some of the conclusions you have just drawn. Please let me know at once whenever you think you want to make changes or have made a new discovery."

(1) This retest gave the subject who had failed to detect the negative instances, one more opportunity to discover them. (2) Those who had failed to see the relationship between the compound characters of the same radical also had another opportunity to discover it during the retest. (3) Those who had even failed to recognize the radicals as having appeared in more than one word might do this during the retest. (4) Those who though able to pick the radicals from the card board could not recall the individual words in which they appeared, were also thus given a chance at this time to reëxamine them.

After the retest, the subject was asked to recall again the characters for the components he had picked out from the card board and to add whatever new discoveries or to make whatever changes he might desire.

(*c*) If the subject still did not detect the negative instances after the retest, the experimenter then pointed out to him the contradictory nature of the instances against which his original conclusions could not hold up, and recorded his reaction to them.

(*d*) If the subject, though able to recognize the radicals and to recall the individual words, failed after the retest to get any meaning for the radicals, the experimenter told him that he could get the meaning by looking for a common relationship among the individual compound characters having the same radical.

(*e*) If the subject, though able to pick out the radicals

from the card board, could not recall the individual words after the retest, the experimenter read these words to him and asked him to guess the meaning of their common component.

(*f*) If the subject failed to recognize the radicals in the card board after the retest, the experimenter then pointed them out to him and asked if he could recognize them, recall the words having them in common, and guess their meanings.

8. *Introspection Discarded.*—No introspective account was taken in this experiment, partly because, as has been previously pointed out, the subjects were not trained, and partly because it was not very feasible to do so in a method of procedure like ours, but more largely because the experimenter had very little confidence in introspection as a scientific method. As a matter of fact the introspection of such subjects could have given no better information concerning their performance in the experiment than did our objective record. As has been previously pointed out, in the discussion of the results we shall not attempt any inference or make any guess as to what might be going on in the so-called 'consciousness' during the performances.

One of the essential features of the technique in the present experiment was to arrange some standard conditions in such a way as to force the subject to transform his silent speech into overt forms so that the experimenter could directly observe the responses of the reactor (subject) instead of the reactor making observations upon himself. We have in two cases used the detective question method to accomplish our purpose. While this method is not as ideal as we would like (since it still involves a personal element on the part of the one who gives the question) it is nevertheless superior to the introspective method in point of scientific accuracy and reliability.

IV. Results

1. *Aspects of Inductive Inference.*—For convenience of discussion we have classified the process of inductive inference into five aspects. They are: (1) reaction to relationship; (2) number of evidences; (3) the nature of hypothesis; (4)

Table I

Subject	Radical	React. Rel.	No. E.	N. H.	D. N. I.	A. N. I.
1	W	A	A	A		
	F	A	A	A	A3	
	M	A	B	B	C1	C
	H	A	B	B	B2	A
	Met.	A	A	B	B2	B1
2	W	A	A	A		
	F	A	A	A	A3	
	M	A	B	B	B2	A
	H	A	A	A	A3	
	Met.	A	B	B	B1	A
3	W	A	A	A		
	F	A	B	B	B1	B1
	M	A	A	A	A2	
	H	A	A	A	A3	
	Met.	A	A	A	A3	
4	W	A	B	A		
	F	A	B	B	B1	B1
	M	A	A	B	B2	A
	H	A	A	A	A3	
	Met.	A	A	A	A3	
5	W	A	A	A		
	F	A	A	B	B2	A
	M	A	A	A	A4	
	H	A	B	B	D	A
	Met.	A	A	A	A1	
6	W	A	A	A		
	F	A	A	B	B2	A
	M	A	A	A	A3	
	H	A	B	B	B1	A
	Met.	A	A	A	A3	
7	W	A	A	A		
	F	A	A	A	A1	
	M	A	A	A	A3	
	H	A	A	A	A3	
	Met.	A	B	B	B1	A
8	W	A	A	A		
	F	A	B	B	B2	D
	M	A	B	B	B2	A
	H	A	A	A	A3	
	Met.	A	A	A	A3	
9	W	A	B	A		
	F	A	A	A	A3	
	M	A	A	A	A3	
	H	A	B	B	D	B2
	Met.	A	A	A	A3	

TABLE I (*Continued*)

Subject	Radical	React. Rel.	No. E.	N. H.	D. N. I.	A. N. I.
10	W	A	B	A		
	F	A	B	B	B_2	D
	M	A	A	A	A_3	
	H	B_1	B	B	C_1	B_3
	Met.	E_1	A	A	A_3	
11	W	F_3				
	F	A	B	B	B_2	A
	M	A	C	C	B_2	B_2
	H	A	C	C	C_2	B_3
	Met.	F_1	C	B	B_2	A
12	W	A	A	A		
	F	A	A	A	A_4	
	M	A	B	B	B_2	A
	H	B_1	C	B	C_1	E
	Met.	A	A	A	A_4	
13	W.	A	C	A		
	F	A	C	A	A_4	
	M	A	C	A	A_3	
	H	A	C	C	C_2	B_1
	Met.	A	C	A	A_3	
14	W	A	C	C	C_2	E
	F	A	B	B	B_2	E
	M	A	C	C	C_2	B_1
	H	B_1	A	A	A_3	
	Met.	F_1	A	A	A_3	
15	W	A	B	A		
	F	A	B	B	B_2	E
	M	A	C	B	C_2	B_3
	H	E_4				
	Met.	B_1	B	A	A_3	
16	W	B_1	B	A		
	F	A	B	B	E	D
	M	A	C	C	B_2	B_1
	H	E_1	B	A	A_3	
	Met.	A	C	B	B_2	D
17	W	A	A	A		
	F	A	B	A	A_3	
	M	E_1	C	C	B_2	A
	H	E_1	D	C	B_2	A
	Met.	A	A	B	B_1	A
18	W	A	A	A		
	F	A	B	B	C_1	C
	M	A	B	B	B_2	A
	H	A	C	B	C_1	A
	Met.	A	C	A	B_2	A

TABLE I (*Continued*)

Subject	Radical	React. Rel.	No. E.	N. H.	D. N. I.	A. N. I.
19	W	A	B	A		
	F	A	B	B	E	C
	M	A	C	C	C1	B1
	H	A	C	C	C1	A
	Met.	A	A	A	A3	
20	W	A	B	A		
	F	A	B	B	C2	B3
	M	F1	C	C	C2	B1
	H	A	A	B	C1	B2
	Met.	F1	C	A	A3	
21	W	A	B	A		
	F	A	B	B	D	A
	M	F1	B	B	C2	B2
	H	A	B	B	C1	A
	Met.	F1	B	A	A3	
22	W	A	B	A		
	F	A	A	A	A3	
	M	A	C	B	B2	A
	H	E1	B	A	A3	
	Met.	A	B	B	D	A
23	W	A	B	A		
	F	A	A	A	A3	
	M	A	C	B	B2	A
	H	E4				
	Met.	A	B	B	C1	A
24	W	A	C	A		
	F	A	C	B	B2	B1
	M	A	C	B	C1	A
	H	E1	A	B	C1	A
	Met.	A	C	C	C2	A
25	W	A	B	A		
	F	A	A	A	A4	
	M	A	C	C	C2	B2
	H	A	B	B	C1	B1
	Met.	A	A	A	A3	
26	W	A	C	A		
	F	A	C	B	C2	E
	M	A	C	B	C2	B3
	H	A	C	B	C1	B3
	Met.	F1	A	A	A3	
27	W	E4				
	F	A	C	B	C1	E
	M	A	C	C	B2	B2
	H	E1	D	C	C2	B1
	Met.	B1	A	A	A3	

TABLE I (*Continued*)

Subject	Radical	React. Rel.	No. E.	N. H.	D. N. I.	A. N. I.
28	W	A	B	A		
	F	A	B	B	B_2	B_1
	M	A	A	A	A_3	
	H	A	C	B	B_2	A
	Met.	A	B	A	A_4	
29	W	B_1	A	A		
	F	A	B	B	B_2	D
	M	A	C	C	C_2	A
	H	A	C	C	C_2	B_3
	Met.	F_1	B	A	A_3	
30	W	A	B	A		
	F	A	C	B	C_1	C
	M	A	C	A	A_4	
	H	A	B	B	C_1	B_1
	Met.	E_4				
31	W	A	A	A		
	F	A	A	A	A_4	
	M	A	B	A	A_3	
	H	A	B	B	D	B_3
	Met.	A	A	A	A_3	
32	W	A	C	A		
	F	A	C	B	B_2	A
	M	A	A	A	A_3	
	H	E_1	D	C	C_2	B_3
	Met.	B_2				
33	W	A	B	A		
	F	E_1	C	B	B_2	C
	M	E_1	C	B	B_2	A
	H	A	C	C	B_2	A
	Met.	E_4				
34	W	A	A	A		
	F	A	A	A	A_4	
	M	A	B	A	A_3	
	H	A	B	B	C_1	A
	Met.	F_3				
35	W	A	C	A		
	F	E_4				
	M	A	C	A	A_4	
	H	B_1	C	C	C_1	B_3
	Met.	E_4				
36	W	A	C	A		
	F	A	C	B	B_2	D
	M	A	C	B	C_2	A
	H	A	A	B	C_1	B_1
	Met.	A	C	B	C_1	A

TABLE I (*Continued*)

Subject	Radical	React. Rel.	No. E.	N. H.	D. N. I.	A. N. I.
37	W	A	B	A		
	F	A	A	A	A_4	
	M	A	C	C	C_2	B_1
	H	A	C	C	C_1	A
	Met.	E_1	C	C	C_1	A
38	W	A	D	C	C_2	E
	F	A	A	A	A_3	
	M	A	C	C	C_1	B_3
	H	A	D	C	C_1	E
	Met.	A	D	C	C_1	B_2
39	W	E_4				
	F	C	B	C	C_1	B_2
	M	A	C	C	C_2	B_2
	H	A	D	C	C_1	B_2
	Met.	E_4				
40	W	A	C	A		
	F	F_1	A	B	C_1	D
	M	E_1	D	C	C_1	D
	H	F_1	D	C	C_1	B_3
	Met.	F_3				
41	W	E_1	B	A		
	F	E_1	B	B	B_2	B_3
	M	A	C	C	C_1	B_2
	H	A	C	C	C_1	B_2
	Met.	F_1	C	B	B_2	B_2
42	W	B_1	A	A		
	F	A	B	B	C_1	B_2
	M	B_1	A	C	C_2	B_3
	H	B_2	B	C	C_1	E
	Met.	B_2	A	B	C_2	E
43	W	E_1	A	A		
	F	A	C	B	C_1	A
	M	A	D	B	C_2	E
	H	E_4				
	Met.	F_3				
44	W	E_4				
	F	A	C	B	D	E
	M	E_4				
	H	F_3				
	Met.	E_4				
45	W	E_4				
	F	C	A	B	C_1	A
	M	E_4				
	H	F_3				
	Met.	E_4				

TABLE I (*Continued*)

Subject	Radical	React. Rel.	No. E.	N. H.	D. N. I.	A. N. I.
46	W	E_4	B	B	E	B_2
	F	E_2				
	M	E_4				
	H	E_4				
	Met.	F_3				
47	W	E_4				
	F	C	B	B	C_2	B_2
	M	E_2	A	C	C_1	B_3
	H	E_2	A	C	C_1	B_3
	Met.	C	A	A	A_3	
48	W	C	A	A		
	F	C	A	B	C_2	A
	M	D				
	H	D				
	Met.	C	A	B	C_1	B_3
49	W	C	A	A		
	F	D				
	M	D				
	H	F_2				
	Met.	F_3				
50	W	F_3				
	F	F_2				
	M	D				
	H	D				
	Met.	D				
51	W	E_4				
	F	D				
	M	D				
	H	D				
	Met.	F_2				
52	W	E_4	A	B	E	B_3
	F	B_1				
	M	E_4				
	H	B_2				
	Met.	F_3				
53	W	E_4				
	F	E_4				
	M	E_4				
	H	E_4				
	Met.	F_3				
54	W	C	A	A		
	F	E_4				
	M	E_2	A	A	A_3	
	H	E_2	A	B	C_1	A
	Met.	F_3				

TABLE I (*Continued*)

Subject	Radical	React. Rel.	No. E.	N. H.	D. N. I.	A. N. I.
55	W	E_4				
	F	B_1	D	C	C_2	D
	M	B_1	D	C	C_1	E
	H	F_3				
	Met.	F_3				
56	W	E_3				
	F	E_3				
	M	D				
	H	D				
	Met.	F_2				
57	W	E_3				
	F	E_4				
	M	E_4				
	H	E_3				
	Met.	F_3				
58	W	E_3				
	F	F_2				
	M	E_3				
	H	E_3				
	Met.	F_3				
59	W	E_4				
	F	B_1	A	A	A_4	
	M	B_1	C	C	B_2	B_1
	H	E_4				
	Met.	F_3				
60	W	D				
	F	D				
	M	D				
	H	E_4				
	Met.	F_3				

detection of negative instances; and (5) attitude toward the negative instances. (These are not steps or stages of the process and should not be confused with the so-called 'stages of reasoning,' so often spoken of in recent psychological writings.) The classification is based only upon the results of the present experiment. Under each of the five aspects we have grouped the reactions of the subjects into several types. The main results of the experiment will be presented and discussed according to these subdivisions. Table I. shows the types of the subjects in each of the five aspects, for each radical. The Roman letters symbolize the types of each aspect (these will be more fully explained shortly).

In this table as well as in the subsequent tables the following abbreviations have been used: 'W' for the water radical; 'F' for the female radical; 'M' for the mouth radical; 'H' for the hand radical; 'Met.' for the metal radical; 'React. Rel.' for reaction to relationship; 'No. E.' for number of evidences; 'N. H.,' for the nature of hypothesis; 'D. N. I.' for detection of negative instances; and 'A. N. I.' for attitude toward negative instances.

2. *Reaction to Relationship.*—By reaction to relationship we mean the act of discovering the common relationship of the compound Chinese characters which is represented by their common structure, namely, the radical, and the act of inferring therefrom the meaning of this radical. The results of our experiment show the following types of reaction to relationship.

Type A.—In this type the subject made an inference regarding the meaning of a radical (regardless of whether or not it was correct) *spontaneously;* that is, he discovered the relationships by himself before Instruction III. was given. Inferences of this type were thus always made before the subject committed all the eighty-eight compound characters to memory.

Type B1.—The subject in this type could discover relationships and make inferences only after Instruction III. had been given.

Type B2.—Though the subject knew, after Instruction III. had been given, that the meanings of the radicals should be found in the common relationships of the compound characters, he failed to get any specific meanings for the radicals.

Type C.—To this type belong those subjects who failed to discover any relationship by themselves after Instruction III. had been given, but who were able to do so and to make inferences regarding the meanings of the radicals after the experimenter had suggested to them that they could get their meanings by looking for common relationship among the compound characters having a common structure.

Type D.—The subject could not find any specific meaning for a radical even after he had been told by the experimenter to look for a common relationship.

(In types, B1, B2, C, and D, the subjects were able to recall sufficient words for making inferences. They could do this before the retest was given.)

Type E1.—In this type the subject, while previously unable to recall the compound characters sufficiently to make inferences, or recalling incorrect characters (that is, characters which really did not belong to the same radical, so that no common relationship among them could be discovered) could, during or after the retest, (*a*) recall them or correct the wrong characters previously recalled, and (*b*) find common relationships and make inferences regardless of whether such inferences were correct or not.

Type E2.—In Type E2, the subject was able to do (*a*) of Type E1, but could do (*b*) of Type E1 only after the experimenter had called his attention to the common relationship existing among the characters of the same radical group.

Type E3.—The subject, while able to do (*a*) of Type E1, could not do (*b*) of Type E1 even after the idea of common relationship had been suggested to him.

Type E4.—The subject failed to do (*a*) of Type E1 and consequently was not able to do (*b*) of type E1 either.

(In Types E1, E2, E3, and E4 the radicals were picked out from the component card board by the student before the retest was given.)

Type F1.—In this type, the subject who had previously failed to pick out the radical from the component card board and to recall the compound characters in which it appeared, and who consequently had been unable to discover any meaning for the radicals, accomplished both (*a*) and (*b*) during or after the retest.

Type F2.—The subject could do (*a*) of Type F1 during or after the retest, by himself, but failed to do (*b*) of Type F1 either by himself or upon the suggestion of common relationship made by the experimenter.

Type F3.—In this type, the subject, even after the retest, failed to pick out the radical from the component card board, or though able to pick it out, failed to recall characters sufficient for making an inference, or recalled wrong characters, so that no inference could be made from them.

TABLE II

Type	W		F		M		H		Met.		Grand Total	P.C.
	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.		
A.....	35	58.3	39	65	37	61.7	28	46.7	23	38.3	162	54
B1.....	3	5	3	5	3	5	4	6.7	2	3.4	15	5
B2.....	0	0	0	0	0	0	2	3.4	2	3.4	4	1.3
C.....	3	5	4	6.7	0	0	0	0	2	3.4	9	3
D.....	1	1.6	3	5	6	10	4	6.7	1	1.7	15	5
E1.....	2	3.4	2	3.4	3	5	6	10	2	3.4	15	5.0
E2.....	0	0	1	1.7	2	3.4	2	3.4	0	0	5	1.6
E3.....	3	5	1	1.7	1	1.7	2	3.4	0	0	7	2.3
E4.....	11	18.3	4	6.7	6	10	7	11.7	6	10	34	11.3
F1.....	0	0	1	1.7	2	3.4	1	1.7	7	11.7	11	3.6
F2.....	0	0	2	3.4	0	0.0	1	1.7	2	3.4	5	1.6
F3.....	2	3.4	0	0	0	0	3	5.0	13	21.7	18	6.0
Total....	60		60		60		60		60		300	

Table II., constructed from Table I., summarizes for each radical the number and percentage of the subjects exhibiting each type of reaction to the relationship. Several facts in this table and in the 'React. Rel.' column of Table I. are noticeable:

1. When we consider the five radicals together, we have 54 per cent. of the total cases that belong to Type A. The percentage of failures to discover relationship thus appears to be very large (46 per cent.). Attention is also called to

the fact that in Type A, twenty-four cases of inferences or conclusions which were merely wild guesses are also included (see Type C in the 'N. H.' column of Table I.). If we eliminate such wild guesses, the percentage of failures will be larger yet (54 per cent.).

2. Of the total failures (that is, of those who failed to discover the meanings of the radicals before Instruction III. was given) 31.2 per cent. belong to Types B1, B2, C, and D; 44.1 per cent. belong to Types E1, E2, E3, and E4; and 24.7 per cent. to Types F1, F2, and F3. In other words, nearly 69 per cent. of the failures to discover the meanings of the radicals before the conclusion of the memory experiment were accompanied either by the inability to recall sufficient characters for inference or by the tendency to recall incorrect characters or by the inability to pick out the radicals from the component card board.

3. The examination of the 'React. Rel.' column in Table I. shows that all the subjects (with the single exception of subject 39) who belong to Type A in one or more radicals, never belong to Type C, or to Type D, or to Type E2, or E3, or F2. It will be remembered that subjects of Types C, D, E2, E3, and F2 are those who can discover the meanings of the radicals only after the suggestion that there exists a common relationship among the characters of the same radical group has been made by the experimenter; or who failed entirely in spite of such suggestion. On the other hand, we find by examining the same column that 93.3 per cent. of Type E1 and 90 per cent. of Type F1 belong to those subjects who were Type A in one or more radicals but who were not able to get any meanings for other radicals because they could not recall the compound characters, or because they recalled incorrect ones, or because they could not recognize the radicals in the component card board; but who could, nevertheless, discover them without any suggestion from the experimenter, as soon as they recovered their ability to recognize the radicals and to recall the correct compound characters. In other words, these subjects might fail, in certain cases, to get the meanings for some of the radicals, but their failure was due to memory

rather than to inability to 'see into' the relationship situation. On the other hand, the failure of the subjects of Types C, D, E2, E3, and F2 is a direct result of their inability to discover the relationship, since they all could recall (either before or after the retest) the compound characters sufficiently to enable them to make inferences.

The case of subject 39 can easily be explained. Note that though this subject belongs to Type A for radicals 'mouth' and 'hand,' his hypotheses with reference to the meanings of these radicals are very wild. Furthermore, the number of evidences he cited to support his conclusions was very few. One would suspect from these facts that this subject did not actually discover the true relationships as represented by these two radicals even though he had hypothesized their meanings. (See Table I. for the record of this subject.)

Mastery of the Compound Characters as a Factor in the Reaction to Relationship.—Table III. gives the average number and percentage of compound characters of each radical which the subject had mastered at the time he discovered their common relationship. It will be noted that for no radical is the average number of the compound characters mastered by the subject smaller than 8.46, or 56.4 per cent. This seems to indicate the importance of the mastery of the compound characters for the discovery of the common relationship existing between them.

TABLE III

	W	F	M	H	Met.
Av. No.....	8.46	8.90	8.79	9.10	9.52
Av. P.C.....	56.4	59.3	58.6	60.7	63.5

3. *Number of Evidences.*—By number of evidences we mean the number of compound characters which the subject could recall to support his conclusion with regard to the meaning of their common radical. For convenience of discussion we have grouped this aspect of the inferential response into the following types:

Type A.—The subject in this type could recall more than five compound characters to support his conclusion.

Type B.—The number of compound characters recalled is from three to five.

Type C.—The number of compound characters recalled is from one to three.

Type D.—In this type the subject drew a conclusion without any evidential support; that is to say, he was not able to recall any compound character to prove his inference as to the meaning of the common radical.

Table IV. gives the number and percentage of the sub-

TABLE IV

Type	W		F		M		H		Met.		Grand Total	P.C.
	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.		
A.....	18	41.9	19	38.0	12	25.5	11	26.2	19	51.1	79	36.2
B.....	16	37.2	20	40.0	8	17.0	13	30.9	8	21.7	65	29.7
C.....	8	18.6	10	20.0	24	51.1	12	28.6	9	24.4	63	28.8
D.....	1	2.3	1	2.0	3	6.4	6	14.3	1	2.7	12	5.5
Total....	43		50		47		42		37		219	

jects for each radical according to the types classified above. Considering the five radicals together, we find that Type A has the largest percentage, while Type D has the smallest. But if we group Types B, C, and D, together, we have 64 per cent. of the cases that do not have more than five instances to prove a conclusion. While we cannot say with certainty that any conclusion, so far as the present experiment is concerned, drawn from only three to five instances, is an illegitimate one, Type C (28.8 per cent.), in which only from one to three evidences were cited, is certainly representative of uncautious inference, although such an inference may sometimes prove correct. In this connection it must be noted that the possible total number of evidences for each radical is fifteen. The tendency in our subjects to draw hasty conclusions is more noticeable in the case of pseudo radicals, where thirty-three (or 55 per cent.) subjects (see Table X.) tried to make inferences from only two instances.

4. *The Nature of the Hypothesis.*—By the nature of hypo-

thesis we mean the correctness or incorrectness of the inference first suggested by the subject regarding the meaning of a given radical. How closely does the first suggested meaning or hypothesis correspond to the actual meaning of the radical? There were three types of this aspect of inductive inference:

Type A.—The first guess or conclusion is the exact meaning of the radical (that is, 'water' for the water radical, 'female' for the female radical, etc.).

Type B.—The first guess, though related or relevant to the actual meaning of the radical, is incorrect on account of the negative instance characters (*e.g.*, 'relative' for the female radical, 'money' for the metal radical, etc.).

Type C.—In this type all the conclusions are merely wild guesses; that is, irrelevant to or very remote from the actual meanings of the radicals (*e.g.*, 'noun' for the water radical, 'verb' for the mouth or hand radical, etc.).

Table V. shows the number and percentage of the subjects

TABLE V

Type	W		F		M		H		Met.		Grand Total	P.C.
	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.		
A.....	41	95.4	15	30.0	14	29.8	8	19.1	22	59.5	100	45.7
B.....	0	0	33	66.0	15	31.9	18	42.9	12	32.5	78	35.6
C.....	2	4.6	2	4.0	18	38.3	16	38.3	3	8.0	41	18.7
Total....	43		50		47		42		37		219	

for each radical according to the types of the nature of hypothesis. This table sums up only the hypotheses first suggested by the subjects; subsequent changes in hypothesis are not included here. Considering the radicals individually, we find that the percentage of Type B (66 per cent.) for the female radical is much larger than that of Type A (30 per cent.) for the same radical; that of Type B (31.9 per cent.) for the mouth radical, a little larger than that of Type A (29.8 per cent.) for the same radical; and that of Type B (42.9 per cent.) for the hand radical also much larger than that of Type A (19.1 per

cent.) for the same radical. On the other hand, for the water radical, 95.4 per cent. belong to Type A, while Type B is 0 per cent. The percentage of Type A for the metal radical (59.5 per cent.) is also larger than that of Type B, (32.5 per cent.) for the same radical. As to Type C, the percentages are very small for radicals water, female, and metal, but considerably larger for radicals mouth and hand. The large percentages of Type C for the last two radicals are to be explained by the fact that we have included such hypotheses as 'verb' and 'infinitive,' which seem to be rather common guesses for these two radicals. The examination of the compound characters in Plate I. having these two radicals, shows that many of these characters are verbs or infinitives. There seems, therefore, to be more or less ground, however inadequate it may be, for the subject's inferring that these two radicals are 'symbols' for verbs or infinitive. Should we exclude, then, the meanings of verbs and infinitive from Type C, the percentages of this type also will not be very large for radicals mouth and hand. At any rate, it seems safe to conclude that most of the first guesses of our subjects are either exact, or very close or relevant to the exact meanings of the radicals. In this connection it is interesting to note that most of the wild guesses (Type C) were got by those subjects who were able to do so only after the suggestion of relationship between the characters had been made by the experimenter. (Such wild guesses are italicized in Table VI.). It appears, then, that if our subjects were able to discover by themselves the relationships at all, the first inferences which they made from such discoveries were in most cases, if not exact, very closely related to the actual meanings of the radicals.

The difference in percentage between Type A and Type B for the different radicals can be explained, in part at least, by the following fact:

The Number of Misleading Characters as a Determinant of the Nature of the Hypothesis.—This point was brought out after the table for frequency of meanings (Table VI.) had been constructed. In this table all the subsequent changes

TABLE VI

W			F			M			H			Met.		
Meaning	No.	P.C.	Meaning	No.	P.C.	Meaning	No.	P.C.	Meaning	No.	P.C.	Meaning	No.	P.C.
nature.....	1	2.3	*animate object*	1	1.35	*music*	1	1.61	force	1	2.05	masculine	1	2
flowing.....	1	2.3	*affection*	1	1.35	*human action*	1	1.61	physical exertion	1	2.05	noun	1	2
infinitive....	1	2.3	*action*	1	1.35	instinctive action	1	1.61	lifting	1	2.05	mineral	5	10
water.....	41	93.3	*body*	1	1.35	*emotional*	1	1.61	work	1	2.05	chemical element	11	22
			expression	1	1.35	*diseased condition in body*	1	1.61	*death*	1	2.05	money	10	20
			family	1	1.35	masculine	1	1.61	effort	1	2.05	metal	22	44
			noun	2	2.70	movement	2	3.22	violent action	2	4.10			
			human being	3	4.06	throat	2	3.22	infinitive	4	8.20			
			personal	9	12.20	lips	2	3.22	motion	7	14.30			
			relative	31	41.90	infinitive	3	4.84	verb	8	16.30			
			female relation	8	10.82	action	4	6.44	action	13	26.50			
			female	15	20.27	speaking	6	9.68	hand	9	18.30			
						verb	10	16.10						
						sound	13	20.97						
						mouth	14	22.58						

in meaning—save that which resulted in the exact meanings of the radicals—are included. General inspection of the table shows that the number of misleading characters (see Plate I.) has great influence upon the frequency of the meanings suggested by the subjects; that is to say, the misleading characters tend to lead the subject to a wrong conclusion in accordance with the common characteristic of such characters, and as the number of misleading characters increases, the frequency of the correspondingly wrong meanings is also increased.

Table VII. shows this effect more clearly. The first horizontal row needs no further explanation. The second horizontal row, labeled 'misled meaning' shows the wrong meaning or meanings for each radical, which were inferred by the subject from the common characteristic of the misleading characters. Rows three and four show the number and percentage respectively of the misleading characters for each radical. (*Cf.* Plate I.). The last two rows give the frequency and percentages of the actual cases in which the subjects were misled by the misleading characters into the formulation of correspondingly wrong inferences. (In the 'female' column, the two meanings, 'family' and 'female relation' are counted as 'relative.') It will be noted that in this table the meanings, 'personal,' 'human being,' or 'person,' for the female radical; 'action,' 'motion,' or movement and other similar meanings for the hand radical; and 'mineral' for the metal radical, are not included: since, it will be recalled, these meanings, though they have been classified as Type B, are broader than the actual connotations of these three radicals, and are to be

TABLE VII

Radical	Female	Mouth		Metal		Water
Misled Meaning	Relative	Talking	Sound	Money	Chemical Elem.	o
No. Misleading Characters	11	3	9	5	6	o
Per Cent	73.3	20.0	60.0	33.3	40.0	o
Frequency	40	6	13	10	11	o
Per Cent	54.0	9.7	21.0	20.0	22.0	o

checked only by the negative instance characters outside the radical group; these are not formed as a result of the subjects' having been misled by the misleading characters. Their frequency, therefore, does not belong in the same class as those shown in Table VII.

While the data shown in the table may not warrant any definite conclusion as there do not seem to be sufficient cases, nevertheless they are indicative of a close relation between the number of misleading characters and the frequency of wrong meanings, formulated upon the basis of their own common characteristic: the latter increase both in absolute number and in percentage as the number and percentage of the former increase.

5. *The Detection of Negative Instances.*—This implies the ability of the subject to take note of the negative instance characters. The following types of detection are found in our experiment:

Type A1.—The subject gives consideration to the negative instance characters outside the radical group before he draws a conclusion, and recalls those within the radical group as positive evidences for his conclusion in case such a conclusion is correct.

Type A2.—The subject draws a correct conclusion and takes into account the negative instance characters outside the radical group before this conclusion is definitely drawn, but does not make use of the negative instance characters within the radical group for the support of his conclusion.

Type A3.—The subject, though drawing a right conclusion, does not consider the negative instance characters outside the group containing the radical, but is able to make use of those within the radical group to support his view.

Type A4.—The subject, though he makes a correct inference, neither considers the negative instance characters outside the radical group nor recalls those within the radical group as positive evidence for his inference.

Type B1.—In this type the subject is able to notice the negative instance characters outside the radical group only after an incorrect conclusion has been drawn.

Type B2.—Same as Type B1, save that in this type the subject could only detect the negative instance characters within the radical group.

Type C1.—The subject draws an incorrect conclusion which is not applicable to the negative instance characters outside the radical group, and remains blind to them until the experimenter, at the end of the experiment, calls his attention to them.

Type C2.—Same as Type C1, save that the negative instance characters which the subject fails to detect are within the radical group entirely.

Type D.—The subject makes an inference which is too broad or too comprehensive, due to his false recognition or false memory for the structure of the negative instance characters outside the radical group; that is to say, he looks upon the negative instance characters outside the radical group as having the same common element (radical) as those compound characters whose common relationship is really represented by this radical. For example, he infers that the hand radical means action, or motion, or movement (instead of hand), because he looks upon the compound characters 'walking,' 'jumping,' and 'to dance' as having also the hand radical as their common element.

Type E.—In Type E the subject includes in the list of compound characters which he recalls the negative instance characters, without realizing the fact that these characters oppose the conclusion.

Table VIII. gives the number and percentage of the types of detection of negative instance characters for each radical. The table shows several striking facts: (1) There are only two cases (1.1 per cent.) belonging to Type A1, and one case (0.6 per cent.) belonging to Type A2. From this fact it seems clear that most of our subjects draw a right conclusion merely by accident; they seldom take into consideration the negative instance characters outside the radical group before the inference is made. This seems to imply that the subjects' inferences are usually confined to the data immediately at hand, at the time of forming an hypothesis; they rarely

TABLE VIII

Type	W		F		M		H		Met.		Grand Total	Per Cent
	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.		
A1.....	0	0	1	2	0	0	0	0	1	2.7	2	1.1
A2.....	0	0	0	0	1	2.2	0	0	0	0	1	0.6
A3.....	0	0	7	14	10	21.3	8	19	18	48.4	43	24.1
A4.....	0	0	7	14	3	6.4	0	0	2	5.4	12	6.7
B1.....	0	0	2	4	0	0.0	1	2.4	3	8.1	6	3.3
B2.....	0	0	14	28	13	27.7	4	9.5	5	13.5	36	20.2
C1.....	0	0	8	16	8	17.0	21	50.0	5	13.5	42	23.6
C2.....	2	100	5	10	12	25.5	5	11.9	2	5.4	26	14.6
D.....	0	0	2	4	0	0.0	3	7.1	1	2.7	6	3.3
E.....	0	0	4	8	0	0.0	0	0.0	0	0.0	4	2.2
Total....	2		50		47		42		37		178	

attempt to analyze the bearings upon their conclusions of things not immediately in sight. On the other hand, (2) considering the five radicals together, we find that forty-three cases (24.1 per cent.) belong to Type A3, whereas there are twelve cases (6.7 per cent.) which belong to Type A4. In other words, if we consider all the cases together in which the subjects get the correct meanings of the radicals in their first conclusion (that is, Types A1, A2, A3, and A4) we find that forty-five (*i.e.*, Types A1 and A3) out of fifty-eight cases, (or 77.9 per cent.) have made use of the negative instance characters within the radical group as positive proofs of their conclusions. This is indicative of the fact that the number and kind of the compound characters the subject can recall or hold together at the time his conclusion is being drawn usually determines the nature of that conclusion: if, besides the misleading characters, he also recalls other compound characters of the same radical group, he usually arrives at a right conclusion; if he recalls, on the other hand, the misleading characters alone, his chances for getting a correct meaning are diminished. This point is further borne out by the fact that, as has been previously shown, the number of misleading characters determine considerably the nature of the hypothesis. (3) The percentage of Type B1 (3.3 per cent.) is much smaller than that of Type B2 (20.2 per cent.), while the percentage of Type C1 (23.6 per cent.) is

larger than that of Type C2 (14.6 per cent.). It thus appears that the negative instance characters outside the radical group are more difficult to detect than those within the radical group. (4) There are forty-two cases belonging to Type C1, and twenty-six belonging to Type C2, making a total of sixty-eight cases (or 38.2 per cent.). If we include Types D and E, we then have seventy-eight cases (43.7 per cent.) in which the subjects failed to detect the negative instances throughout the experiment. From these facts it seems evident that people are very apt to overlook cases which would contradict their original conclusions.

6. *Attitude toward the Negative Instances.*—By this we mean the reaction of the subject brought about by the discovery of the negative instance characters, which negate his previously formed hypothesis, whether it is discovered by himself or pointed out by the experimenter. What does he do when he realizes the contradiction? We here again classify the results of this aspect of the process of induction into several types:

Type A.—After the negative instance characters have been discovered, the subject immediately changes his hypothesis so as to avoid contradiction. In this type the right meaning of the radical is got at the first instance of the change; that is, on the first trial after the correction.

Type B.—As a result of the discovery of the negative instances the subject attempts various random guesses, until: (B1) he finally gets the correct meaning by himself; (B2) he finally gets the correct meaning only by following the suggestion and guidance of the experimenter; (B3) he is unable to get the right meaning despite the suggestion and guidance of the experimenter.

Type C.—In this type, the subject, when confronted by the negative instances, instead of changing his original hypothesis to meet the situation, attempts some 'far-fetched' interpretation so as to smooth over, as it were, his difficulty; that is to say, he tries to make the negative instances fit in with his incorrect hypothesis so that the contradiction can be explained away. For example, some of our subjects first

concluded that the female radical was a symbol or sign for relative. This conclusion was later negated by the compound character, 'tutoress.' To explain away this difficulty, our subjects insisted that tutoress could be looked upon as a member of the family, so that there was no serious objection to the hypothesis that the radical meant relative, or relation.

Type D.—Although the subject realizes that his hypothesis has been invalidated, yet he is unwilling to make any change, as though it would cost him too dearly to give up his 'pet' (but erroneous) theory; he is happy with it, in spite of the contradiction.

Type E.—In this type, the subject is at a loss when he is confronted by the negative instances; he realizes that his original hypothesis is incorrect, but he cannot think of anything else to substitute for it. It appears as if he were emotionally upset by the contradiction, and his word association gets 'stuck' so that he gives up the problem 'as a bad job,' and declares that it is impossible to get any meaning for the radical. Despite the repeated assurance of the experimenter that he can get the right meaning if he thinks it over carefully again, he refuses to go any further.

Table IX. gives the number and percentage of the types of the attitude toward the negative instances for each radical. It will be noted that nearly half of the cases succeed in correcting their hypothesis (Types A and B1); the other half result in failure of various types. The percentage of

TABLE IX

Type	W		F		M		H		Met.		Grand Total	Cent Per
	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.		
A.....	0	0	8	22.8	12	36.4	13	38.2	10	62.5	43	35.8
B1.....	0	0	4	11.4	6	18.2	5	14.7	1	6.2	16	13.3
B2.....	0	0	4	11.4	6	18.2	4	11.4	2	12.5	16	13.3
B3.....	0	0	3	8.5	5	15.1	9	26.5	1	6.2	18	15.0
C.....	0	0	4	11.4	1	3.0	0	0.0	0	0.0	5	4.1
D.....	0	0	7	20.0	1	3.0	0	0.0	1	6.2	9	7.5
E.....	2	100	5	14.2	2	6.1	3	8.8	1	6.2	13	10.9
Total....	2		35		33		34		16		120	

far-fetched interpretation is not very large (Type C), but as we shall see presently this type of attitude is relatively common in the cases of pseudo radicals.

7. *Reaction to the Pseudo Radicals: Elimination of Non-Essential Elements.*—For the sake of brevity, only three aspects of the reaction to the pseudo radicals are distinguished. They are: (1) The ability to eliminate the pseudo radicals as non-essential elements. (2) The detection of negative instance characters in the cases where the subjects first attempt to infer the meanings of the pseudo radicals from one or two instances, and (3) the attitude toward the negative instances. We have divided each of these aspects into three types:

(1) The ability to eliminate the pseudo radicals as non-essential elements.

Type A.—The subject readily assumes the impossibility of getting any connection between the characters having a pseudo radical in common, and infers that as far as the meanings of the individual compound characters are concerned, the pseudo radical has no significance.

Type B.—The subject attempts an inference concerning the meaning of a pseudo radical when he sees that there seems to be a common connection between two (in very rare cases, three) compound characters, which possess this pseudo radical as their component in common. For example, the pseudo radical appearing in 'fierce beast' and in 'mother-in-law' (see Plate I.) is often taken to signify 'cruelty' or 'fearfulness,' etc. This kind of inference may be considered a very uncautious one, since it is, in the most cases, drawn from only two instances; ordinarily a third instance will upset it.

Type C.—The subject in this type neither attempts any inference concerning the meaning of the pseudo radical nor eliminates it as a non-essential element.

(2) The detection of negative instances. As has been pointed out previously, a common relation, however remote or far-fetched it may be, may be established between two compound characters having a pseudo radical in common, but a third character will usually destroy such a relation.

(For example, the compound character 'agate' (or 'mark')—See Plate I.—having the same pseudo radical as 'fierce beast' and 'mother-in-law,' will make it impossible to establish a relationship between the latter two compound characters.) This third character is regarded here as a negative instance character. It is obvious that the ability to eliminate the pseudo radical as a non-essential element depends upon the ability to detect such negative instance characters.

Type A.—The negative instance characters are discovered by the subject before the conclusion regarding the meaning of a pseudo radical is drawn, so that he readily eliminates it as a non-essential element. (Only the subjects of Type A of the previous section belong here.)

Type B.—The negative instances are discovered only after a meaning for a pseudo radical has been inferred.

Type C.—The subject fails to take note of the negative instance characters until the experimenter calls his attention to them at the end of the experiment.

(3) The attitude toward the negative instances.

Type A.—Upon the discovery of the negative instances, the subject readily withdraws his previously formed hypothesis or refrains from making any inference in case he has not attempted it before.

Type B.—A far-fetched interpretation is given by the subject so as to make the negative instance fit in with his original hypothesis. For example, many a subject who had concluded that the pseudo radical appearing in 'bell' and in 'singing' signified sound or music, would insist that the character 'aunt' was not necessarily an evidence against the conclusion, as the aunt might sing or play music to her niece or nephew.

Type C.—The subject is unwilling to give up his theory, though he realizes that it cannot be applied to the negative instances.

In Table X, the subjects are classified according to the type of each of these three aspects of the reaction to the pseudo radicals. Two things in this table are worthy of notice: (1) the tendency toward uncautious conclusion is very

marked (thirty-three cases, or 55 per cent.); and (2) the cases of far-fetched interpretation are also numerous (fourteen cases, or 29.8 per cent.).

TABLE X

Subject	React. Rel.	D.N.I.	A. N. I.	Subject	React. Rel.	D. N. I.	A. N. I.
1.....	B	B	A	31.....	A	A	A
2.....	A	A	A	32.....	B	B	A
3.....	B	B	B	33.....	B	B	B
4.....	A	A	A	34.....	B	B	A
5.....	A	A	A	35.....	B	C	B
6.....	A	A	A	36.....	B	B	A
7.....	A	A	A	37.....	B	B	A
8.....	B	B	B	38.....	B	B	A
9.....	A	A	A	39.....	B	B	A
10.....	A	A	A	40.....	B	C	C
11.....	B	B	A	41.....	B	B	A
12.....	A	A	A	42.....	B	B	A
13.....	B	B	A	43.....	B	B	B
14.....	B	B	A	44.....	B	C	C
15.....	B	B	C	45.....	B	C	C
16.....	B	B	B	46.....	C		
17.....	A	A	A	47.....	B	B	B
18.....	B	B	B	48.....	C		
19.....	B	C	B	49.....	C		
20.....	B	C	B	50.....	C		
21.....	A	A	A	51.....	C		
22.....	A	A	A	52.....	C		
23.....	B	B	B	53.....	C		
24.....	B	C	B	54.....	C		
25.....	A	A	A	55.....	C		
26.....	B	B	B	56.....	C		
27.....	B	B	A	57.....	C		
28.....	A	A	A	58.....	C		
29.....	B	C	B	59.....	B	B	C
30.....	B	B	A	60.....	C		

	React. Rel.	D. N. I.	A. N. I.
Total number of A's.....	14	14	28
Per cent.....	23.3	29.8	59.5
Total number of B's.....	33	25	14
Per cent.....	55.0	53.2	29.8
Total number of C's.....	13	8	5
Per cent.....	21.7	17.0	10.6
Grand total.....	60	47	47

8. *Relative Difficulty of the Radicals.*—We have previously noted that there is evidence that some of the common relationships represented by the radicals are more difficult to discover than others. Of the sixty subjects, thirty-five (or

58.3 per cent.) discovered a meaning for the water radical before Instruction III. was given; thirty-nine (or 65 per cent.) discovered a meaning for the female radical; thirty-seven (or 61.7 per cent.), for the mouth radical; twenty-eight (or 46.7 per cent.), for the hand radical; and twenty-three (or 38.3 per cent.), for the metal radical. (See Table II., Type A.) It thus appears that the series containing the radicals hand and metal are more difficult than the other three. This is further confirmed by the fact that the average number of compound characters mastered by the subjects at the time of the discovery of the meanings of the radicals is larger for the hand and metal radicals than for the other three. (See Table III.) The average trial (repetition) number on which the relationships were discovered also points to the same conclusion; that is to say, it required more trials for the discovery of the meanings of radicals hand and metal than for the other radicals. (The figures not given here.)

9. *Relation between the Discovery of Relationship and Memory, and between the Former and the Discrimination of the Components in the Card Board.*—This question is two-fold: Is the person who can memorize characters rapidly also keen in discovering relationships? And is the person who is good in picking out correct components from the card board also good in the discovery of relationships? To answer these two questions we have grouped the sixty subjects into six groups according to the number of the relationships of the five radicals they are able to discover before they complete the memory experiment.

Group I. consists of those who discover the relationships of all five radicals.

Group II. consists of those who discover four of the relationships.

Group III. consists of those who discover three of the relationships.

Group IV. consists of those who discover two.

Group V. consists of those who discover only one.

Group VI. consists of those who discover none of the relationships.

Our question can now be stated more definitely: Are the persons of group I. better than those of group II. in memorizing the compound characters and in picking out correct components from the card board; and those of group II. better than those of group III.; etc? Table XI. gives for each

TABLE XI

Group I.				Group II.				Group III.			
No. of Comp.	No. of Cor. Comp.	No. R's	Total Rep's	No. of Comp.	No. of Cor. Comp.	No. R's	Total Rep's	No. of Comp.	No. of Cor. Comp.	No. R's	Total Rep's
11	8	5	9.2	14.6	7.9	4.6	8.5	11.3	7.2	4.2	10.3

Group IV.				Group V.				Group VI.			
No. of Comp.	No. of Cor. Comp.	No. R's	Total Rep's	No. of Comp.	No. of Cor. Comp.	No. R's	Total Rep's	No. of Comp.	No. of Cor. Comp.	No. R's	Total Rep's
11.7	7	4.3	7.5	12.6	6.6	3.3	8.5	14.7	7.1	3.7	10.9

group the average number of components (no. of comp.) picked out from the card board; the average number of correct components (no. of cor. comp.) (*i.e.*, they really appear in more than one compound character); the average number of radicals (no. of rs.) included among them; and the averaged total repetitions required for each subject to master the eighty-eight compound characters. It can easily be seen that a good 'memorizer' of characters is not necessarily a good 'discoverer' of relationships, although, as has been previously shown, it requires a certain degree of mastery of the compound characters for discovering the relationships. Group IV., on an average, are the best 'memorizers' (7.5 repetitions). Group V. are just as good as group II. (8.5 repetitions). And though group VI. appear to be the slowest learners (10.9 repetitions), group III. are only a little better (10.3 repetitions). And, finally, group I. stands only fourth in memorizing. The same is true of the relation between the ability

to discover relationships and the ability to pick out correct radicals. Despite the fact that on an average groups V. and VI. seem to have a tendency to pick out more components but with a smaller percentage of correct ones than the other groups, and that group I. seem to have a greater percentage of correct components than the others, the evidence here is too meager to enable us to establish anything like a certain relation between the two. It should be noted, in this connection, that although on an average groups V. and VI. have picked out fewer radicals than groups III. and IV., and though the latter two have picked out fewer than groups I. and II., the fact is clear that one may be able to recognize correctly the radicals in the card board and yet be unable to discover any relationship whatever, as can be clearly shown in group VI. (detailed record not presented here), in which many subjects can even pick out from four to five radicals but fail to get any meaning at all. In other words, the discovery of the radicals is not necessarily accompanied by the discovery of their meanings.

This leads us to another question, namely, is the discovery of the radical earlier or later than that of its meaning? There are eighty-one cases in which the radicals and their meanings are discovered simultaneously, sixteen cases in which the discovery of meanings is made before that of radicals, and sixty-five cases in which the radicals are discovered before their meanings. It thus appears that in rare cases the meaning of a radical is discovered before the radical itself. And in such cases it is implied that the subject, though able to discover the meaning of a radical, is not able to pick the radical out from the card board.

V. Summary and Concluding Statement

We may now summarize the main features of the results of the experiment.

1. On the basis of the results of the experiment we have classified the process of inductive inference into five aspects, namely: (1) reaction to relationship; (2) number of evidences; (3) the nature of the hypothesis; (4) the detection of negative

instances; and (5) the attitude toward the negative instances. Each of these five aspects is subdivided into various types according to the modes of response found in the experiment.

(1) *Reaction to Relationship.*—(*a*) Nearly half of our subjects failed to find the common relationships of the compound characters spontaneously; (*b*) a certain degree of mastery of the compound characters was found to be a necessary prerequisite for discovering relationships.

(2) *Number of Evidences.*—There was a tendency among many of our subjects to draw hasty conclusions; that is, conclusions drawn with relatively few instances in their support. This tendency was more marked in the cases of pseudo radicals in which a conclusion was in most cases drawn from only two instances.

(3) *The Nature of the Hypothesis.*—(*a*) Most of the guesses made by the subjects were either exact or close to the actual meanings of the radicals; wild guesses were not very numerous. (*b*) The number of misleading characters played an important part in determining the nature of the hypothesis which the subject formulated.

(4) *The Detection of Negative Instances.*—(*a*) Subjects seldom took into consideration the negative instance characters outside the radical group before they drew a conclusion. Inferences were made from the positive cases of compound characters which had common structures; the bearings upon them of compound characters having no similar structures were usually not considered. Negative instance characters outside the radical group functioned only as checks against wrong inferences. Correct conclusions were often merely happy guesses. If a subject who happened by accident to get the correct meaning for a radical were of this type he still might not notice the existence of such negative instance characters throughout the whole experiment. (*b*) The nature of a conclusion (whether it was perfectly correct or merely partially correct) depended to a considerable extent upon the number and kind of compound characters the subject could recall or hold together at the time the conclusion was being drawn. The ability to recall, besides the misleading char-

acters, other compound characters of the same radical, was usually necessary for arriving at a correct conclusion. (*c*) The negative instance characters outside the radical group were more difficult to detect than were those within the radical group. (*d*) Over 40 per cent. of all cases considered failed to detect the negative instances and the subject did not realize the incorrectness of his conclusions until the experimenter called his attention to them.

(5) *Attitude toward the Negative Instances.*—Half of all the cases considered succeeded in reformulating correct hypotheses after the subjects had discovered that their original hypotheses had been invalidated by the negative instances. The other half constituted various types of failure; far-fetched interpretations and unwillingness to give up pet ideas were among the noticeable cases. Far-fetched interpretation was especially marked in the cases of pseudo radicals.

2. A good 'memorizer' of characters was not necessarily a good 'discoverer' of relationships. There was also no important relation between the ability of the subjects to discover relationships and to pick out the common structures of the compound characters from the component card board.

3. The common relationships of the series containing the 'hand' and 'metal' radicals were found to be more difficult to discover than those of the series having the other three radicals.

I consider this experiment as a preliminary one and present it simply to show the possibility of objective studies in this direction and to invite criticisms and suggestions for improvement of the technique. I am fully mindful of the fact that the method used in this experiment is not completely adequate and has short-comings. I therefore refrain from making any widespread generalizations from the results. I also refrain from attempting any theoretical discussion concerning the process of inductive inference and from making any social and educational applications of the results. I do not think that such attempts are justifiable in view of the fact that the present methods are not refined enough to take care of all the important factors involved in the process. Nor

am I inclined to explain the ability or disability in discovering relationships, or in detecting the negative instances, in terms of any conventional theory of innate or hereditary factors. Anything short of laboratory acquaintance with the life history of the individual, and short of adequate objective control of all the factors operating in the experiment, must not be offered as an explanation for the different modes of responses displayed by the subjects in this experiment.

In fact, I am interested more in the development of the technique than in the results. The results, as such, are of value only in so far as they have indicated that my attempt at the objective study of this type of language response is not altogether futile, and have suggested new lines for further research. Were it not for the limitation of space, I should like to discuss the shortcomings of this experiment which I have discovered and to give an account of the improved method which I shall hope to use in the near future for a more extensive study with special emphasis on the quantitative aspects of the process. I shall do this in a later report if I succeed in carrying out my project. I found that the Chinese characters did not work very satisfactorily for quantitative control. I am, therefore, devising some non-Chinese material for the purpose, and I hope to be able to analyze the modes of response involved in the process of inductive inference more minutely and completely than I have done in this paper. From this future study I hope to be able also to develop a genetic scale so as to compare the modes of inferential response in children of various ages or grades, and in adults.

While it is admittedly true that the process of inductive inference is among the most complicated types of reaction in the speaking animal, there is much hope that it will ultimately yield to objective control. Indeed, I am convinced that the time will soon come when we shall be able to study such types of language reaction with reasonable adequacy and certainty without using the method of introspection.

THE INFLUENCE OF LIKES AND DISLIKES ON MEMORY AS RELATED TO PERSONALITY

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I. Historical

The mental adhesive, affective-tone, has received much emphasis in regard to its rôle in the functioning of memory. In some psychological systems affective-tone is assumed to furnish the key to the understanding of mental life and behavior. It is at the core of complexes for the psychoanalyst. It is at the basis of learning in the form of satisfyers and annoyers for the educator.

Not until relatively recently has there been any experimental evidence upon which to base such assumptions. The scientific evidence favoring the adoption of affective-tone as a key principle, even in such limited functions as memory or learning, is still very meagre, the dozen or more valid surveys of this influence containing much irrelevant, conflicting, and negative material. The more careful work seems to throw some doubt upon the validity of assuming such a principle.

Ranschburg (10), in interpreting his experimental results on learning gives unequivocal emphasis to the fact that inhibition in learning may depend upon emotional-tone, among other variables. But there is little in his experimental results to give validity to such an interpretation. Meumann (7), also, is of the opinion that pleasantness facilitates the function of memory.

Colegrove (3) attempted a direct study of any influence which pleasantness or unpleasantness might have upon memory. He used a questionary for probing the feeling-tone of the memories of a large number of subjects. He found a predominance of pleasant memories over unpleasant. Sex

differences were also obtained, female subjects having relatively more unpleasant recalls than males. Another study of the influence of affective factors in recall was made by Myers (9). Again the pleasant experiences recalled greatly exceeded the unpleasant. Hollingworth (6) presents a general discussion, the trend of which is to indicate that the disagreeable oblivesces more than the agreeable.

This general problem has been approached from another angle by Tait (12), who investigated the speed with which lists of words differing in pleasantness-unpleasantness were learned. It was found that feeling-tone, either pleasant or unpleasant, increased the rapidity of memorizing. The pleasant lists, however, had much the greater betterment on learning, while the unpleasant words were in turn learned easier than those of an indifferent feeling-tone. Tolman (13) obtained confirmatory results. This later investigator found that the following repetitions were necessary to learn the various lists:

11.5 repetitions for pleasant lists
12.7 repetitions for indifferent lists
13.5 repetitions for unpleasant lists

It will be noted that in these results there is a gradual increase in the inhibition of the memory connections from the pleasant, through the indifferent, and into the unpleasant. In this the findings differ from Tait's.

Another angle from which the relationship between memory and feeling-tone has been attacked is that of the reproduction or association time. Birnbaum (2) used stimuli consisting of groups of pleasant, unpleasant, and indifferent words, with five hospital attendants serving as his subjects. He found no characteristic or significant difference from group to group. Tolman and Johnson (14) performed essentially the same experiment but found that there was a difference, namely, that the unpleasant words tended to lengthen the association time. This lengthening is greater in the case of females than males.

The recent work of Smith (11) stands by itself. This investigator found that emotional differences brought about a

difference in the memorizing of words. It is not possible for the emotional changes in his subjects to be compared with the introspective reports of the subjects of other investigators inasmuch as Smith used objective measures of emotional change. He found that a marked emotional-tone may result in the words being better or poorer remembered. Accordingly he assumes that he was measuring two sorts of emotional disturbance, the one which facilitated, or a *positive* tone, and the other which inhibited, or a *negative* tone.

We now turn to some investigations, which, although on the surface appear as confirming the results which we have taken up previous to these, nevertheless are looked upon by their authors as demonstrating that we do *not* forget the disagreeable.

Henderson (5) had ten subjects give one hundred incidents from their past lives. Then they were rated by the subject according to the affective-tone of the incident. Their spontaneous recalls distributed themselves as follows:

55.1 per cent. of agreeable incidents
11.8 per cent. of indifferent incidents
33.1 per cent. of disagreeable incidents

Henderson does not interpret these results as meaning that the pleasant tends to be remembered better than the unpleasant. Rather he looks upon these results as indicating the obvious fact that the majority of the experiences of life are not disagreeable, and accordingly the disagreeable are not in the majority in the recall. He is further inclined to think that if it were really known what portion of the total experiences had been pleasant and which unpleasant that it would be found that there had really been a predominance of recall of the unpleasant.

Apparently Griffitts takes this work of Henderson for his point of departure (4). He accepts the argument for more pleasant than unpleasant experiences. But he went further and attempted to measure the influence of the matter of pleasantness in certain experiences that were experimentally determined. After three presentations of lists of words varying in feeling tone and measuring the recall he found no

tendency for words with unpleasant associations to be repressed, so far as indicated by number of recalls. He concluded that there is, so far as his results show, no evidence of the unpleasant being forgotten.

Still another approach to this general problem was used by Baxter, Yamada, and Washburn (1). They found that it took a longer time to recall unpleasant experiences. The chief significance of their work, however, lies in the positive correlation which they found between a cheerful temperament and slow recall of unpleasant experiences. The findings for moody, melancholic temperaments did not show this slow recall of the unpleasant. Among the unpleasant experiences recalled physical unpleasantness exceeded mental unpleasantness, due, so the authors think, to the tendency for unpleasant mental experiences to be repressed. They thus almost assume the point that we are chiefly concerned with here, although their data do not bear upon it.

A later study from the Vassar laboratory by Morgan, Mull, and Washburn (8) continued the investigation of the personal equation in pleasant and unpleasant recall. Again it was found that cheerful observers tended on the whole to have fewer unpleasant associations than moody observers.

II. Experimental

The present study is concerned chiefly with the personal equation, as it might be called, which seems to facilitate recall of the pleasant or the unpleasant as the case may be. Originally the experiment was devised as a class demonstration, but when the results were gone over in detail several important features were found that are not dealt with in the works that have been reviewed. The loose ends of procedure in the report to follow will betray that the original objective was a demonstration rather than an experiment.

A group of sixty-two beginning students in psychology were told to prepare a sheet of paper by writing their names at the top and then numbering ten lines in a column below their names. They were then told to write down as rapidly as possible the names of the first people they could think of

on these ten lines. If they thought of people faster than they could write down the names initials were to be put down as a memory reminder and the full name written in immediately after the close of this part of the experiment. The only restriction was that they limit their recalls to persons with whom they were acquainted. This was found necessary in some preliminary work in which the names of Volstead and Debs appeared with amazing frequency for an innocent group of serious college students.

Upon the completion of this part of the experiment a forty-minute interval was spent in the regular class work. At the close of the class hour and unexpectedly they were told to take another sheet of paper and write thereon the names of ten people, arranged according to likeableness or dislikeableness. The person whom they liked the most was to be numbered one. The person most disliked was to be numbered ten and placed at the bottom of the list. Eight other people were to be arranged between these extremes in as nearly equal steps as possible by these subjective ratings.

Thus we have repeated, in a crude way, the experiments of earlier students on the distribution of pleasantness among recalls. But the present experiment went further in this respect: as a part of the course in psychology these same subjects had written a psychological sketch of themselves. Emotional-tone especially was to be the main topic and they were to make a serious survey of themselves and their family and diagnose each as to optimistic, pessimistic, or mixed temperament. A later assignment had the students write similar sketches of each other, so we have a double check upon their optimism or pessimism.

If the emotional tone of past experiences does have any influence upon the memories therefor one would expect on *a priori* grounds to find a difference in the recall of these temperamentally separated groups.

III. Results

Since the students did not arrange the ten spontaneous recalls in the order of decreasing liking, not all of the names

arranged in order of liking appear on the recall lists. Exact coincidence of the recall and liking arrangements would have given a correspondence in 620 instances. In other words there were 620 recalls on the part of the sixty-two observers. In actuality, however, there were only 185 of the names on the recall lists appearing in the lists arranged according to liking. This is a per cent. of coincidence of about 30.

Examining the three temperamental groups we find minor, but, as later portions of the results will show, significant differences. This per cent. of coincidence between the appearance of the names on both lists calculated with the possible as a basis is given in Table I.

TABLE I

Type of Observer	Number of Observers	Possible Coincidences	Actual Coincidences	Per cent. of Actual Coincidences
Optimistic	23	230	58	25.2
Pessimistic	7	70	22	31.4
Mixed	32	320	105	32.2
Totals	62	620	185	

A more detailed analysis of the same data is made in Table II. In this table the actual occurrence of a name from the liking list in the recall list is indicated for the three groups of observers and by order of liking. These results are given in per cents. which are calculated with the total *possible* number of recalls in each group as a base.

TABLE II

Type of Observer	Feeling Value of Names Liking → to → Intense Disliking									
	1	2	3	4	5	6	7	8	9	10
Optimistic	4.7	5.6	4.7	3.0	1.7	1.7	1.7	1.7	0.4	0.0
Mixed	5.9	4.6	4.3	5.1	3.6	3.0	3.0	1.5	0.9	0.3
Pessimistic	1.4	0.0	2.8	4.3	5.7	2.8	5.7	2.8	2.8	2.8
All observers	5.0	4.5	4.5	4.3	3.0	2.4	2.9	1.7	0.9	0.9

Giving attention first to the summary under the line of *All Observers* we find that the most liked person was thought of on the spontaneous, free recall over five times as frequently as the most disliked persons were. This is in terms of the per cent. of actual recall out of the total possible. When we consider the actual numbers of recall of these two hypothetical, for our purposes, people, we find that it is 31 to 3, or ten times the recall of the most liked over the most disliked.

Again significant group differences are present which overshadow the central tendencies of our hypothetical average subject. For the purposes of a better comparison these are presented visually in Chart I. In this chart the horizontal row of figures represents the degrees of feeling value assigned by the students. The vertical represents the per cents. of Table II.

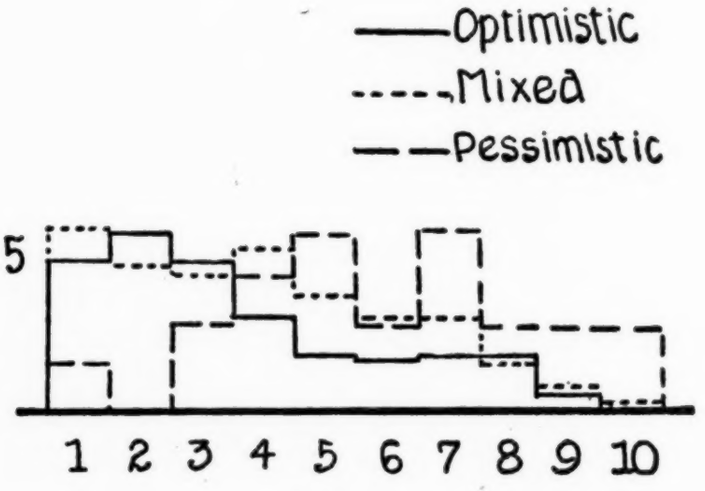

CHART I

The recalls of the group who designated themselves and were also classified by their fellows as characteristically optimistic are found lumped toward the liking end. The group with a mixed temperament are scattered throughout the scale, but more toward the liking end. Contrasted with these two groups are the pessimists with their recalls lumped toward the middle and low end of the scale. But even among these there is found a large per cent. in the first point on the scale.

Assuming that the optimists have had more pleasant

experiences than the pessimists or the mixed groups we find that these results do not necessarily indicate the oblivescence of the displeasing. Recall of pleasant or unpleasant seems to be largely a matter of temperament.

Treating the data as was done for Table II. but using, not the total possible number of recalls for each group as the basis for calculation, but the *actual* number of recalls, we obtain Table III. The data from this table are tabulated in Chart II. The difference between the groups of observers is

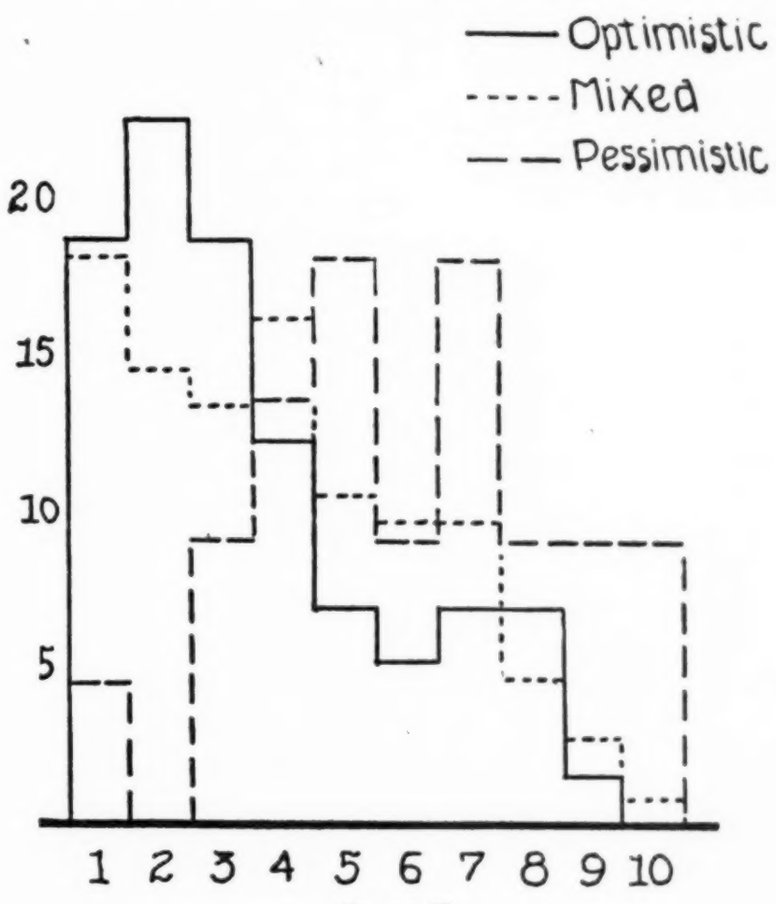

CHART II

thus seen to be greater in the working of their actual memory rather than the ideally perfect.

About seventy-two per cent. of the actual recalls of the group of optimists were distributed among the best liked names. With this same group about only fifteen per cent. of the actual recalls were among the lower four points in the scale of likes. The mixed dispositions have sixty per cent. of

recalls among the higher four and eighteen among the lower four. The pessimists have twenty-seven per cent. of their recalls among the upper four points on the scale of liking and forty-five per cent. among the lower four.

TABLE III

Type of Observer	Feeling Value of Names Liking to Intense Disliking									
	1	2	3	4	5	6	7	8	9	10
Optimistic	18.9	22.4	18.9	12.1	6.9	5.1	6.9	6.9	1.6	0.0
Mixed	18.1	14.3	13.3	16.1	10.5	9.5	9.5	4.7	2.8	0.9
Pessimistic	4.5	0.0	9.0	13.5	18.2	9.0	18.2	9.0	9.0	9.0

Recall of the pleasant or of the unpleasant is thus seen to be more dependent upon temperament that was apparent when checked off against a theoretically perfect coincidence. When the actual coincidence is used it is found that this temperamental difference is very marked indeed. The method by which the data were obtained also is more common to the memory of daily life since there was no restricting the likes-dislikes list to persons named on the original recall list.

It is not at all improbable that this temperamental difference in recalls has much to do with the opinions of various speculators who based their conclusions upon the words in the dictionary or their own memories. The present writer is enough of an optimist that he reluctantly has to give up the opinion that the unpleasant oblivesces.

An interesting observation made in checking over the individual papers was that those who classed themselves as pessimistic and were also so classed by their fellow students were invariably above the average, very much so, in scholarship. Their average, however, in intelligence was below the class average. Considering their equipment they were getting more out of their work, in practically all classes, than their more lighthearted fellows. Assuming that life to them was painfully toned the unpleasant was not oblivescing; or, perhaps, it was a basal seriousness that encouraged more earnest work before the time comes when their work is done.

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THE RESISTANCE OF INFANTS AND CHILDREN DURING MENTAL TESTS

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The problem of coöperation during mental tests is especially important in the early ages. Screaming, struggling, kicking, clinging to the mother, are manifestations frequent in the first four years though rarely observed in testing children of school age. Such behavior often invalidates tests that may be well chosen from a psychometric viewpoint. Psychologists at the Institute for Juvenile Research are all agreed that the 'imitation' test in the Kuhlman two year level, for example, is the least 'acceptable'; *i.e.*, children are more resistant during this test than during any other in his series. This holds true whether the testing is done under the adverse conditions of a 'Better Baby Conference' held in the County Fair or under the natural conditions of the nursery. Moreover eight psychologists (four men, four women), experienced in testing at the numerous baby conferences held in Chicago and throughout the State of Illinois in the past four years, are agreed that regardless of the test used, more difficulty in giving the tests is encountered with the three-year-olds than with any other age group.

This behavior presents an important problem because it interferes with testing. But this practical consideration involves the study of this resistance as a problem of human behavior, since it must be determined whether the resistance is inherent in the tests chosen, in the technic of their administration, in the surroundings, or in the group that is tested. The psychologist interested in formulating new tests for infants and children must consider this factor when devising tests. The student of behavior is interested primarily in knowing whether this behavior is incidental to the testing

and therefore a technical consideration, or whether it is evidence of some fundamental behavior pattern.

In this paper we have tabulated the results of a study of the behavior of seven groups of 983 infants and children during mental tests. For each group the number of difficult cases in every age has been determined as a whole, and in relation to the amount of resistance; the criterion for this amount being the number of tests taken. Immediately after each child was tested, a mark was written on a line denoting age and in a column denoting the amount of resistance—complete, partial, or none. Each sheet contains, therefore, data on the number of children tested, their ages by months, and the amount of resistance during the tests for each age level.

In evaluating the significance of this resistant behavior the problems involved are considered in the following order:

1. The criteria for classification into groups,
2. Reactions to the individual examiner,
3. The factor of coaxing and the time interval,
4. Reaction to particular type of tests,
5. Standardizing of test-situations for different age levels,
6. Place, time and other factors.

The criteria for classification into groups were most objective in Group I—the 'complete resistance' group. Under this heading were included all those who could not be induced to take even one test of any series. Their behavior typically was constant struggling during the test, screaming, loud crying, clinging to the mother, pushing toys away or throwing them to the floor, slapping the examiner; or apparently complete passivity, making no response to any question or command, no grasping of objects placed in their palms. They are classified not by their behavior but by the criterion—'takes not one test.' In Group II., the 'partial resistance' group, we included all those who took some tests, one or more, but not all. We excepted, however, the 'imitation test' because it was resisted so uniformly by the vast majority in all ages. Typical of this group were children who responded to the first test, then hid their faces in the

mother's lap and could not be coaxed away; children who did well while sitting on the mother's lap but struggled and cried when taken from her; or those who did well until they were placed on a table, when they would cry with arms stretched out to the mother. Group III. is a doubtful group. In it we included cases not classifiable in Group IV., the 'coöperative' group, or in Group II., the 'partial resistance' group, because although they took all the tests they required an unusual amount of coaxing. This group was not included in some of the reports. Where it is omitted, it is understood that Group IV. includes those who took all the tests regardless of the amount of coaxing used. Where it is used Group IV. is understood to include all those who took all the tests with little or no coaxing. Group III. included that small number who after resisting as in Groups I. or II., changed front and coöperated; typically all those who had to be coaxed after each test; those who took all the tests even though crying throughout the examination.

These groups cannot all be classified with the same degree of objectivity. Group I. is the most satisfactory in this respect. Regardless of the type of behavior manifested the objective criterion is constant and needs no interpretation—'takes not one test.' We may assume, however, a possible individual reaction to the examiner, for it is conceivable that Group I. behavior might in some instances be a personal reaction to examiner *A*, though not to examiner *B*, or that the immediate resistance might be overcome by *A*, though not by *B*, in which case classification would shift from Group I. (*B*'s classification) to Group II. or III. (*A*'s classification). This influence of the personal factor would be more apparent, if it exists, in Group II., where the resistance is only partial, though the criterion for classification remains objective—'takes some tests but not all.' The examiner's skill in preventing and overcoming resistance, *i.e.*, his 'way with children,' would have very little chance to operate in Group I., because in this group vigorous opposition in almost all cases was encountered practically on entry before the testing was even begun, and was maintained throughout the examination

with very few 'recoveries' by three different examiners. Moreover, the percentage of children in the complete resistance group was practically the same for these three examiners each working independently in different communities. For the other groups, this problem is considered in the discussion of the graphs. Group III. is classified with most difficulty. As in Group IV. the objective criterion is—'takes all the tests,' but in Group III. some resistance had to be broken down. Just how much coaxing makes for Group III. and how much 'spontaneity' for Group IV., is difficult to decide. There is a marked difference and one easy to record between two children, one of whom cheerfully goes through all the performances set, leaving the room smiling; the other, nestling closely to the mother, shaking her head when toys are placed near her yet who by assiduous coaxing after each test can be made to take all of them. But there are many degrees between these two that are hard to classify. Though we had no difficulty in determining Groups I. and II. except in very few instances, we had differences of opinion about Group III. Moreover the problem of what constitutes coaxing and its standardization, has not been attacked. Whatever it is, and however it is applied, the parents of the children were no more successful with it in getting coöperation with Group I. than we. "Of course, he won't do it for you, you're not his mother," said one of the women in Watseka. ("You try it.") She did, with no success. Similar experiences were repeated many times with the same result.

The factor of coaxing as adverse to this classification is important only in a relative way. Let us suppose, for example, that with sufficient time and an improved technic examiner *A* could overcome every case of resistance enumerated under Groups I. and II. and complete every test in his series. He would then have most difficulty with Group I. —less with Group II., least with Group III. and none with Group IV. He could then run the same curves of resistance with a new criterion;—not the number of tests taken but the time consumed in overcoming resistance. With a small group of sixteen infants and children studied in the nursery of a

private home, ranging in ages from 19 months to 4½ years, we found 9 cases of resistance. Taking the number of tests as the standard for classification and using the same methods as in the Baby Conferences, we 'recovered' every resistance of Group I. type. The difference, it appeared to us, was chiefly in the time factor; since we allowed an average of thirty minutes per case instead of the ten-minute average for the Better Baby Conferences. The difference in place, a familiar, quiet nursery room instead of a strange, noisy room in a building on the fair grounds, did not seem important with this small group, inasmuch as the resistance in five cases was typically Group I. in type, immediate and active opposition overcome apparently by the same type of coaxing, over however the longer period. This small group consisted of sixteen wealthy children in good health, presenting no behavior or developmental problems. Nine of them were classified in Groups II. and III. proportionately as many as in our larger series. The number is too small for direct comparison, but large enough to show that even in a small group varying in ages from one to five years, though examined in a familiar home environment, a large amount of resistance is manifested.[1]

Intelligence tests in themselves are apparently not adapted to this classification, since the demands on coöperation vary in the different age groups. In these studies the Kuhlman tests were used for those under three; the Stanford-Binet for those above three. In the Kuhlman series the six-month tests, for example, are largely neuromuscular; ability to sit, to balance the head, turn to the direction of sound, reach for and hold an object. Obviously a child can be tested out in this way while crying vigorously. On the other hand, the two-year-old is required to point out objects in pictures, to imitate simple movements, to obey simple commands. He must *listen* to the words of the examiner, he must watch his motions and must obey his commands to 'do this, do that,' to tell 'what is this, what is that.' The examiner is notoriously inside this test situation because he is constantly

[1] These sixteen cases were not included in the total lists.

evoking responses that are directed to himself. If the child tends to resist the examiner as another individual, that resistance should increase in proportion to the number and intensity of social contacts inside a test situation. In the simplest type of tests, *e.g.*, the six-month 'tests,' which are merely phases of the infant's neuromuscular development, the test is practically independent of any behavior on the part of the tester. When he hands the child an object concealed in loose paper wrapping, which the child uncovers and so secures the object, he supplies a stimulus for a situation in which however he does not enter. He remains outside and records results. His role as an individual according to our experience becomes progressively important in the following test situations: making marks with a pencil and handing the pencil to the child; pointing to an object in a picture and asking "What's that?"; asking questions requiring oral replies. There seems to be no doubt that the 'easiest tests to take' are those in which the subject is doing something with an object and not with the psychologist.

To equalize the demands on coöperation for the different ages, we arranged a series of tests to yield a more comparable measure of resistance. In this series all ages excluding those under six months were tested on the mother's lap, then on the floor and then on a table. They were lifted from one position to the other by the examiner. In this process certain factors in resistance common to all the groups were established. A child taking all tests on the mother's lap might resist being lifted off her lap to the floor. Not resisting on the floor it might resist while being lifted on to the table or after being placed on it. The resistance at these points was not a reaction to tests though it was always carried over into the test situation that followed. But for each group, the factors in the act of changing the child's position were the same for all. Experience showed that resistance occurred oftener on the table than on the floor, oftener on the floor than on the mother's lap. Moreover, in the three groups studied in this manner, there was no significant difference in the amount or distribution of their resistance, from the four groups tested by the Kuhlman and Stanford Binet.

To equalize the test-situations in themselves, tests common to every age-group from 6 to 60 months were used. While on the mother's lap all were tested in grasping objects in front, above, and behind the head, regardless of age. On the floor a rubber ball was thrown to every child after making several throwing gestures and saying, 'catch the ball.' Whether caught or not, the ball was picked up by the child or placed in its hands and then told to 'throw the ball to me' with a 'receiving' gesture. The ball was then placed on the table in a position inaccessible except by walking around it or climbing upon an adjoining chair. The examiner then pointed to the ball which was visible to the child and urged, 'get the ball.' Following this test the child was placed on the table, given the Kuhlman imitation tests and then told, 'all over now, you can go.' Tests of the type indicated do not present the same situation to different age groups. Nevertheless it cannot be inferred that they are therefore of varying degrees of difficulty. Take for example the test in which you throw a ball to the child and then indicate orally and with gestures 'throw the ball to me'—a test used with children though as a 'success and failure' command-test for the two-year level.[1] An eighteen-month-old child might make no receiving movements for the ball, but pick it off the floor and carry it to the examiner. A 24-month child might throw it into the air. A 3-year-old might throw it directly to him. In each case it is a game, in which the child does things it can do. This is in no sense a situation in which the child is up against a problem in which it fails or succeeds. Resistance in such a test-situation cannot therefore be interpreted as a reaction to a difficult problem. Regardless, however, of differences in resistance to tests of different types, the group reactions where our series was used was not materially changed. The particular type of tests used or the technic of their administration has most likely little bearing on resistance when measured by a test or time criterion.

These studies were made in Better Baby Conferences

[1] See Kuhlman, F., 'Handbook of Mental Tests,' Warwick and York, Baltimore, 1922, p. 93.

under unfavorable conditions. The conferences were held in special buildings on the county fair grounds. The inducement to enter a child was the free physical examination and the chance of a prize. Before taking the mental tests each child was undressed except for bloomers or diapers, and inspected by a physician to rule out all cases of contagious disease. The undressing, medical inspection and temperature taking immediately preceded the mental testing. Many other variable factors preceded our tests. In the afternoon groups especially, hunger, fatigue and excitement were evident factors since many families spent the morning 'taking in' the exciting pleasures of the fair. To some children, especially those from remote communities, the sight of many people was a new experience. Some infants were awakened from sleep or pulled away from the breast immediately before the tests. This however caused practically no difference in the coöperation of the three and six month olds, who allowed themselves to be taken from the mother with no crying or struggling in almost every case. During the testing, which averaged 8 to 12 minutes per case, there was much distraction due to the noise of the surrounding activities and to the crowds pressing close to the glass partition separating them from the mental testing room. Our observations were confined to that room, from the point of entry to the point of exit. The varied experiences preceding the point of entry were of course not considered. Their effect, if at all significant, on coöperation would tend to throw at least some graphs out of any uniformity. Since seven groups varying in size from 55 to 237 cases in six different communities were studied separately, these factors would have a strong chance to skew the curves. Moreover in the small group of sixteen, previously referred to, the factors of nakedness, fatigue, hunger, and excitement—all the adverse conditions during examinations in the county fairs, were eliminated without any reduction in the number of resistance-problems. We may conclude then that resistance during testing is not measurably affected by the experiences preceding the tests or by the testing room.

The groups are fairly representative of the healthy rural

population of the state. The six towns were well scattered. Farmers' children comprised the majority in four, native miners' children in three conferences. No acutely ill child was accepted and children with gross defects were rarely seen. Towns forming the county seats where the conferences were held, have an average population of about 3,000.[1]

The accompanying tables contain the source data for all the graphs that follow. In Table I. are distributed by age in six-month groups all cases in each of the seven conferences. The smallest total age group (34) occurs at 0 to 5 months. This group is not included in the graphs because the tests at this level are purely neuromuscular and no basis of comparison with the other groups is offered. Resistance, if it can be said to exist at this age, can manifest itself only in crying when taken from the mother. Scores of resistance on this basis, since they almost always respond to the tests, shows not one case in Groups I., II. or III.

The age classification is in groups of 6 months up to the 54th month. Above 54 months, 19 cases age 60 to 63 months are included. This was done for convenience to make a group more comparable in size to the others. As it is, it and the 48–53 month groups are the smallest. The scores of the group of 19 treated separately are 0 per cent. in Group I., 5 per cent. each in Group II. and III. The range in size of the groups is 104 to 194 for those under 30 months, 61 to 91 for those over 30 months.

In Table II. all cases are distributed by age and residence in each of the four resistance groups. The residence is taken as the town in which the tests were given. The table represents the ratio of resistance-groups to age-groups. Group I., II. and IV., as already mentioned, are based on test criteria, classifiable as 'take no tests,' 'take some tests,' and 'take all tests,' respectively. Group III. is an 'all tests' group but

[1] Classification of parents' occupations in our lists was made in Watseka (pop. census 1920, 2817) and Sparta (pop. census 1920, 3340).

Watseka: Farmers 55 per cent.; business and professional 16; mechanics 15; laborers 7; miscellaneous 7.

Sparta: Miners 35 per cent.; business and professional 19; mechanics 24; farmers 9; clerical 7; miscellaneous 6.

with 'much coaxing.' It is included as a separate group in three conferences. Where it occurs Group IV. signifies 'take all tests with little or no coaxing.' As explained previously, Group III. is not based on the objective criteria of the other groups.

TABLE I

DISTRIBUTION OF ALL CASES BY AGE AND RESIDENCE

Age in Mos.	Watseka, 1921	Benton, 1921	Marion, 1921	Carthage, 1921	Carrollton, 1921	Sparta, 1922	Watseka, 1922	Total
0–5	2	6	7	9	5	5	0	34
6–11....	23	39	23	5	39	12	53	194
12–17....	14	16	27	6	39	6	39	147
18–23....	20	22	14	5	20	18	25	124
24–29....	13	15	12	11	21	7	25	104
30–35....	9	14	10	8	15	7	28	91
36–41....	6	13	9	4	21	6	19	78
42–47....	3	22	4	0	31	5	18	83
48–53....	5	16	3	7	11	5	14	61
54 +....	15	9	4	0	20	3	16	67
Total....	110	172	113	55	222	74	237	983

TABLE II

DISTRIBUTION OF ALL CASES IN EACH OF THE FOUR GROUPS BY AGE AND RESIDENCE

Group I. (*Complete Resistance*)

Age in Mos.	Watseka, 1921		Benton, 1921		Marion, 1921		Carthage, 1921		Carrollton, 1921		Sparta, 1922		Watseka, 1922	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0–5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6–11.....	1	4	0	0	0	0	0	0	0	0	0	0	4	7
12–17.....	0	0	1	6	1	4	1	17	5	13	1	17	4	10
18–23.....	1	5	4	*18*	4	*28*	0	0	3	*15*	1	5	6	*24*
24–29.....	4	31	2	13	3	25	3	*27*	1	5	4	**57**	5	20
30–35.....	3	**33**	5	**36**	4	**40**	2	25	3	20	0	0	7	25
36–41.....	1	17	2	15	3	33	2	**50**	4	19	3	*50*	6	**31**
42–47.....	0	0	0	0	1	25	0	0	8	**26**	2	40	3	17
48–53.....	1	20	0	0	0	0	0	0	2	18	1	20	0	0
54 +.....	0	0	0	0	0	0	0	0	1	7	0	0	3	19

Group II. (Partial Resistance)

0–5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6–11.....	2	9	2	5	0	0	0	0	2	8	0	0	1	19
12–17.....	1	21	3	19	4	15	0	0	7	23	1	17	2	54
18–23.....	8	50	11	50	3	21	2	40	7	40	6	33	6	24
24–29.....	3	38	5	33	3	25	1	9	9	67	0	0	2	18
30–35.....	4	44	4	29	4	40	2	50	4	53	3	43	5	17
36–41.....	4	67	4	31	3	33	0	0	5	28	1	16	1	53
42–47.....	2	67	7	32	2	50	0	0	3	23	1	20	2	11
48–53.....	1	20	3	19	2	67	1	14	1	9	0	0	0	0
54 +.....	1	15	0	0	1	25	0	0	0	7	0	0	1	6

Group III

0–5.....	0	0							0	0			0	0
6–11.....	0	0							1	3			0	0
12–17.....	2	14							2	6			4	10
18–23.....	2	10							1	5			2	8
24–29.....	2	15							5	24			2	8
30–35.....	0	0							4	26			5	17
36–41.....	0	0							1	5			6	31
42–47.....	0	0							4	13			1	5
48–53.....	0	0							0	0			3	21
54 +.....	1	7							1	5			0	0

Group IV. (Take all Tests)

0–5.....	2		6		7		9		5		5		0	
6–11.....	20		37		23		5		36		12		48	
12–17.....	11		12		22		5		25		14		29	
18–23.....	9		7		7		3		9		11		11	
24–29.....	4		8		6		7		6		3		16	
30–35.....	2		5		2		4		4		4		11	
36–41.....	1		7		3		2		11		2		6	
42–47.....	1		15		1		0		16		2		12	
48–53.....	3		13		1		6		8		4		11	
54 +.....	13		9		3		0		18		3		12	

Table III. is a summary table showing the distribution by number and percentage of all cases in age and resistance groups. Groups I. and II., total plus partial resistances, and Groups I., II. and III., resistances of all types, are each recorded as inclusive groups in separate columns.

In 581 cases the sex was recorded—310 males and 271 females. The sex of all cases was indicated in two conferences (Sparta and Watseka, 1922); and in most of the cases in two others (Carrollton and Watseka, 1921).

Distributed by type of resistance over ten age groups the numbers became very small. The sexes are compared therefore in inclusive groups and are so indicated in Table IV.

TABLE III

SUMMARY TABLE SHOWING TOTAL NUMBER AND PERCENTAGE DISTRIBUTION BY AGE OF ALL CASES CLASSIFIED IN THE FOUR 'RESISTANCE' GROUPS

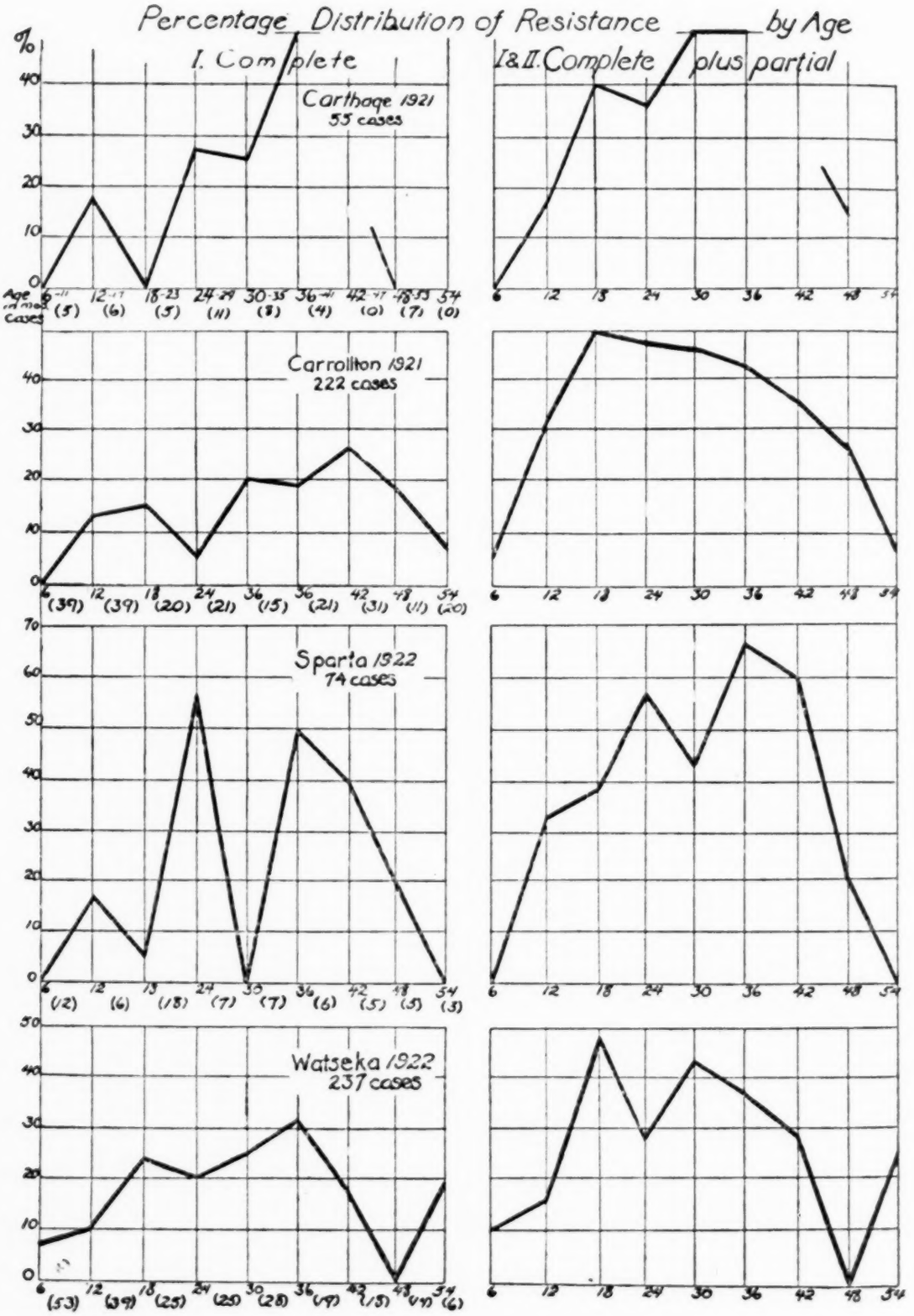
Ages	I		II		III		IV		I and II		I, II and III		Total cases
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
0–5	0	0.0	0	0.0	0	0.0	34	100.0	0	0.0	0	0.0	34
6–11	5	2.6	7	3.6	1	0.5	181	93.3	12	6.2	13	6.7	194
12–17	13	8.8	15	10.2	11	7.5	108	73.5	28	19.2	39	26.5	147
18–23	19	15.3	42	33.9	6	4.8	57	45.9	61	49.1	67	54	124
24–29	22	21.2	22	21.2	10	9.6	50	48	44	42.3	54	51.9	104
30–35	24	26.4	26	28.6	9	9.9	32	35.2	50	54.9	59	65	91
36–41	21	26.9	15	19.2	10	12.8	32	41.0	36	46.1	46	59	78
42–47	14	16.9	12	14.5	10	12.0	47	56.6	26	31.3	36	43.4	83
48–53	4	6.6	6	9.8	5	8.2	46	75.4	10	16.4	15	24.6	61
54+	4	6.0	2	3.0	3	4.5	58	86.6	6	8.9	9	13.4	67
Total	126	12.8	147	15.0	65	6.6	645	65.6	273	27.8	338	34.4	983

TABLE IV

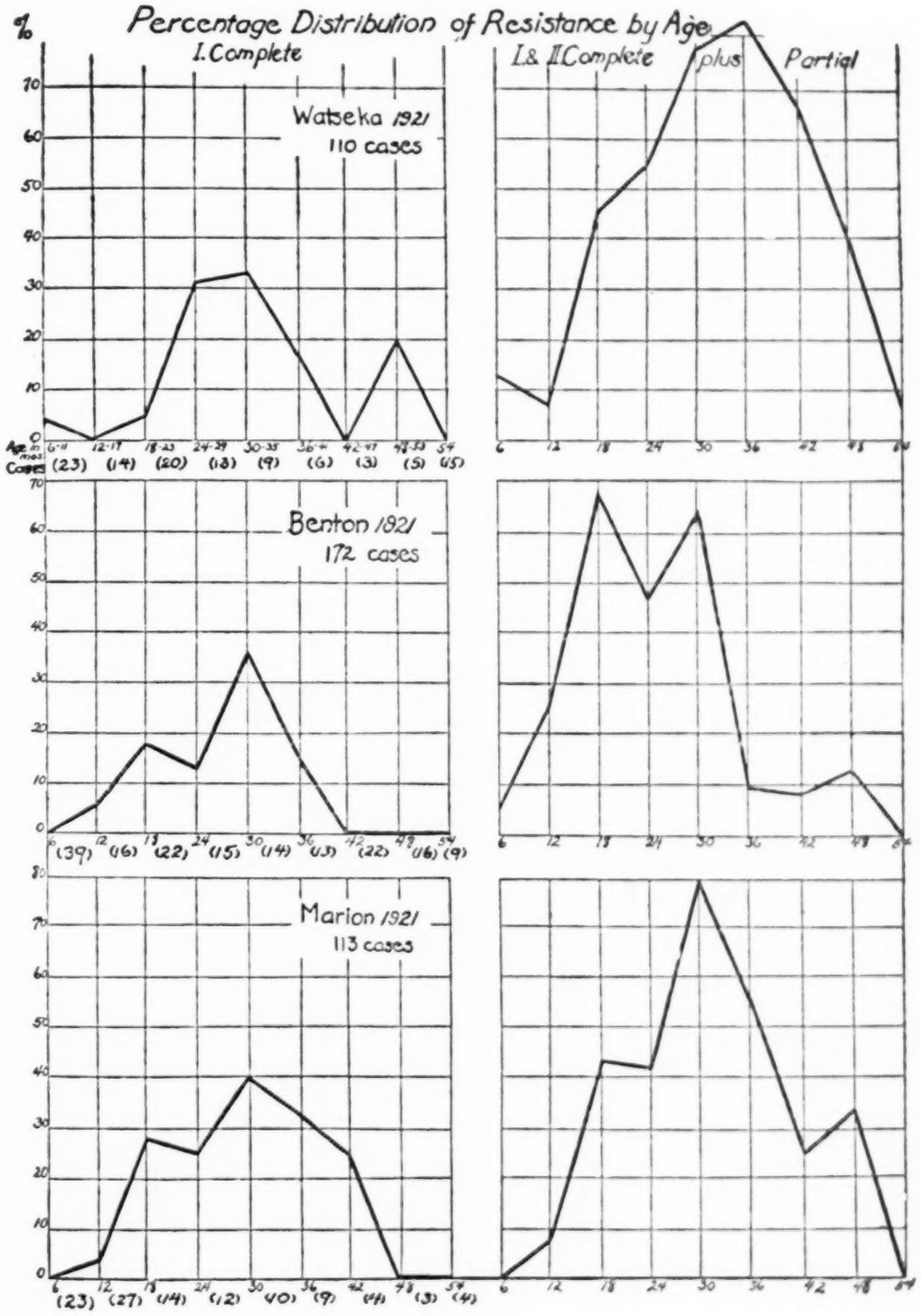
SEX DISTRIBUTION OF 581 CASES BY AGE AND RESISTANCE-GROUPS

Age in Mos.	Watseka, 1921		Watseka, 1922		Carrollton, 1921		Sparta, 1922		Total		Group I and II, Total				Group I, II and III, Total			
	No. Male	No. Fem.	M.	F.	M.	F.	M.	F.	M.	F.	M.	%	F.	%	M.	%	F.	%
9–5	0	2	0	0	2	3	5	0	7	5	0	0	0	0	0	0	0	0
6–11	12	5	29	24	15	5	7	5	63	39	5	7.9	3	7.7	5	7.9	4	10.2
12–17	7	1	22	17	18	14	2	4	49	36	7	14.2	9	25	10	20.4	13	36.1
18–23	10	6	11	14	8	10	10	8	39	38	14	35.8	20	52.6	16	41.0	22	57.9
24–29	6	5	17	8	10	11	3	4	36	28	14	38.8	13	46.4	18	50	18	64.3
30–35	3	4	15	13	10	3	4	3	32	23	16	50	11	47.8	23	71.8	13	56.5
36–41	1	3	12	7	10	11	5	1	28	22	11	39.2	10	45.4	16	57.1	14	63.6
42–47	0	3	7	11	12	19	1	4	20	37	7	35	14	37.8	9	45.0	17	45.9
48–53	2	1	7	7	2	9	3	2	14	19	0	0	4	21	2	14.2	5	26.3
54+	3	4	8	8	10	10	1	2	22	24	2	9.1	3	12.5	2	9.1	5	20.8
Total	44	34	128	109	97	95	41	33	310	271	76		87		35		51	

The graphs follow the tables in the same order. Those showing distribution of total resistance are on the right; total plus partial resistance on the left side of the page. Three summary graphs follow: Number 1, for the complete resistance group (Group I.); Number 2, for complete plus partial resistance (Groups I. and II.); Number 3, for all the resistance


Percentage Distribution of Resistance by Age
I. Complete
I & II. Complete plus partial
%
Carthage 1921
55 cases
Carrollton 1921
222 cases
Sparta 1922
74 cases
Watseka 1922
237 cases
Age at last birthday
Number of cases

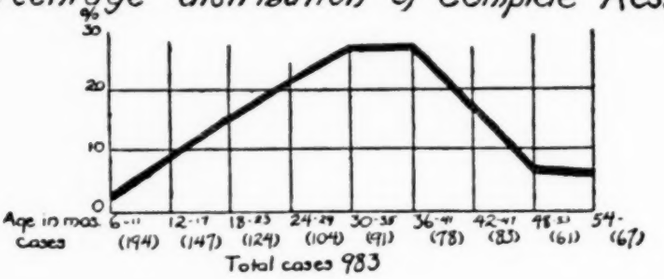
GRAPH I


Percentage Distribution of Resistance by Age
I. Complete
I & II Complete plus Partial
Watseka 1921
110 cases
Benton 1921
172 cases
Marion 1921
113 cases
%
Age in mos.
Cases

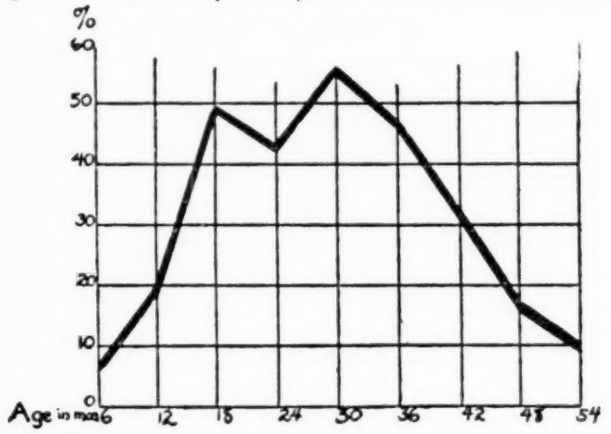
GRAPH 2

Summary Graphs

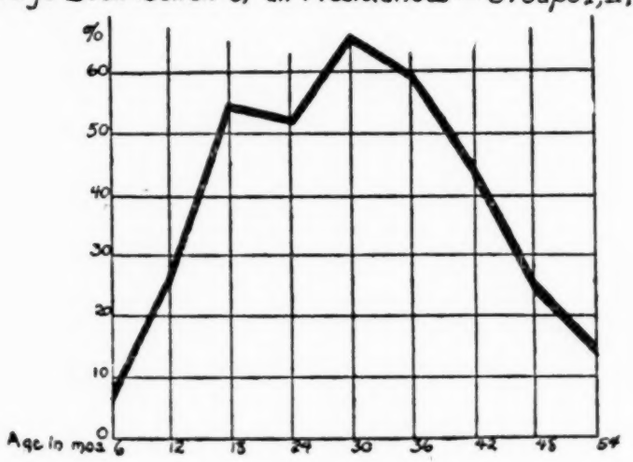
I. Percentage distribution of Complete Resistance



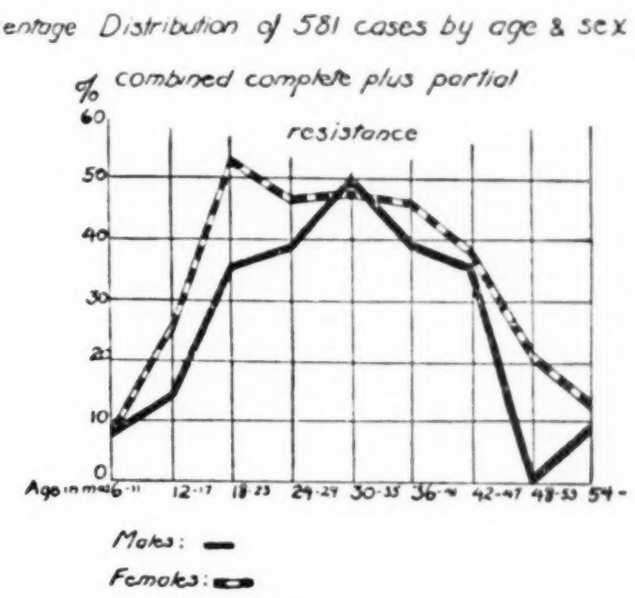
II. Percentage Distribution of Complete & Partial Resistance



III. Percentage Distribution of all Resistances — Groups I, II, & III.



GRAPH 3



GRAPH 4

Groups I., II. and III. A graph showing the sex distribution of 581 cases in relation to the first two resistance groups combined, completes the series.

The Group I. graphs (pp. 316–317) have this tendency in common—a rise from a zero or low level at six months to a peak, and a fall to a low level at 42 to 54 months, the peak being more or less centrally placed with reference to points 6 and 54 on the age-level line. The peak represents the highest percentage of total resistance for a series. This point is lowest at 26 (Carrollton) highest at 57 (Sparta). The wide range of 26 to 57 per cent. is explainable by chance variations due to the small size of some age groups. Groups less than one hundred distributed over 9 age levels contain as few as 3, 4 and 5 cases in some levels and the difference in the reaction of one child has a marked effect on the percentage of resistance. As will be seen on the graphs, wide gapping is most frequent where groups are very small. On the other hand when in spite of wide fluctuations in size and consequent increase in the operation of chance factors, uniform tendencies are observed, they have all the more significance. If each separate graph which stands for a group as small as 55 or as large as 237 shows the same general tendencies exhibited by a summary graph for 983 cases, it increases the significance

of conclusions based on the summary graph. It shows that the tendency is so prevalent that it is manifested by small groups.

The peak is at the 30- or 36-month level in five towns, at 24 in one (Sparta) and at 42 in one (Carrollton). A lower peak precedes the high one in six of the seven towns; at 18 months in four and at 24 in two (Carthage and Sparta). The high or 'primary' peak occurs at 30 or 36 months in five out of seven towns, the low or 'secondary' peak at 18 or 24 months in five out of seven. In one graph the situation is reversed, the primary peak being at 24, the secondary at the 36-month level.

These findings are shown more strikingly in the series of graphs on the right side of the page, since they include larger numbers—total plus partial resistances. The gradual rise and fall with a central high point of resistance is more uniform. The primary peak rises to a height of 83 and is lowest at 47. Double peaks are seen in five. Thirty or 36 is the primary peak in five out of seven graphs, eighteen is primary in the other two. Secondary peaks occur on the 18- or 24-month level in three; at the 30-month level in two.

The percentage distribution of complete resistance for the entire series of 983 cases is shown in summary graph I. A uniform rise of 5 to 6 per cent. (range 5.2 to 6.2, average 5.95) for each age group occurs up to the thirty month level where a plateau is maintained to the next age level at 36, after which there is a 10 per cent. descent (10.0 and 10.3) for each age group to the 48 month. From here onward the low level of resistance is maintained at 6 per cent. There are two peaks in this graph at the same height, 26.

In summary graph II. which includes both resistance Groups I. and II. the rise is 12 per cent. for the 12-month group, with a precipitate rise from that point of 30 per cent. for the 18-month group. Then follows a descent of 7 per cent. at the 24-month level and a rise to the peak of the graph, 55 per cent. at the 30-month level. From this point on there is a fall, 8.8 per cent. at the 36-month level, and 15 per cent. each at 42 and 48 months, the low level occurring at 8.5 per

cent. for the 54-month group. We have in this graph two peaks, the higher at 30 and the lower at the 18-month level in common with the observation on the individual graphs. Graph I. is more uniform than Graph II., the secondary peaks observed on the individual graphs being elided in the total average. Also unlike Graph II. there is a more gradual rise than fall. Summary Graph III. is similar to II. contrasting chiefly in the height of the secondary peak and the slighter drop to the next age group.

The explanation of the secondary peaks is found in summary Graph IV. which shows the percentage distribution by sex of 581 cases; 310 males, 271 females. Distributed by sex over nine age levels made a list too small to be treated except in summary form. The males reach their high point of resistance at the thirty-month level; the females at eighteen. In this graph the female peak is higher than the male; in fact, higher than the male level at every point except at 30 months. The explanation of the peaks is found therefore in the sex distribution within each age group. A preponderance of females 18 to 23 months of age, tends to make the peak at 18 primary. A preponderance of males 30 to 35 months of age tends to make the peak at 30 primary. Contrast for example males and females on these levels.

(SPARTA AND WATSEKA) 1922

Age	No. Cases	Groups I and II		Both Sexes
		No.	%	
18 to 23 months	17 males	6	35.3	48.7
	22 females	13	59.1	
30 to 35 months	19 males	9	47.3	42.8
	16 females	6	37.5	

SUMMARY

A study of the 'resistance' during mental testing was made for seven groups of infants and children in five County Fairs. The criterion for classification was the number of tests taken. Those who could not be induced to take one test of

any series were classified in Group I. (complete resistance); one or more but not all of any series, in Group II. (partial resistance); all tests, in Group III. Nine hundred and eighty-three infants and children were classified in these groups by three examiners working independently. The results were fairly uniform for each group. They were not materially affected by changes made in the technic of testing, by using new tests, by different examiners, or by change in locality. A small group of sixteen used as a control, tested with a new series of tests, in a nursery, and over a longer interval of time, gave practically the same findings. This resistance, best designated in the graphs, occurs very frequently for age and sex in a fairly uniform way. It first appears as measured by the method indicated at six months, gradually rises to a high point from which it falls gradually to a low level at 54 months. This high point of resistance for males is highest at 30 months; for females at 18 months. The resistance in the latter group is higher than the males at every age group studied except 30. At 30 months, some form of resistance measured by the test criterion occurred in a majority of cases.

Conclusion

The manifestation of resistance by infants and children during mental tests is evidence of some innate behavior pattern. It is typically pronounced at 18 to 23 months in females, and at 30 to 35 months in males. It yields gradually with age in both sexes.